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New information perspectives

Positioning techniques for location-based services: characteristics and limitations of proposed solutions
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Part 2
Innovative information-accessing opportunities and the researcher: user acceptance of IT-based information resources in academia
Eti Herman

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CONTENTS

404–412 Positioning techniques for location-based services: characteristics and limitations of proposed solutions
David Mountain and Jonathan Raper

413–422 Custom interfaces for advanced queries in search engines
Mike Thelwall, Ray Binns, Gareth Harries, Teresa Page-Kennedy, Liz Price and David Wilkinson

423–430 The five maxims of project satisfaction
Andrew Boyd

431–457 End-users in academia: meeting the information needs of university researchers in an electronic age
Part 2
Innovative information-accessing opportunities and the researcher: user acceptance of IT-based information resources in academia
Eti Herman

Positioning techniques for location-based services (LBS): characteristics and limitations of proposed solutions

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Location-based services are touted as the 'killer applications' of the mobile information revolution. This paper highlights some of the technical characteristics and limitations inherent in current mobile positioning technologies in order to set the current optimism surrounding Location-Based Services (LBS) in context. A complex technical situation is revealed with different technologies providing results with very different spatial characteristics. Most current terrestrial solutions fail to provide results of sufficiently high spatial resolution for many of the proposed LBS applications, and satellite based solutions suffer from problems of reception and coverage in built up areas. The issue of georeferencing the services themselves is tackled and further work needs to be done on providing accurate spatial locations on the vast array of services that could be available through LBS.

A current reluctance to temper these claims could arguably lead to unrealistic raising of the expectations of the buying public. The proven vulnerability of new technology to the fickleness of market opinion highlights that the technology may stand or fall not on its own merits, but on how it matches the expectations of the user

Introduction

Location-based services (2001) are frequently hailed as the 'next killer application'. The technical and mainstream press alike are awash with articles describing the utopian future scenarios that they promise are just around the corner (Schrope, 2000; Webb and Graham-Rowe, 2000). However, there are arguably vested interests in describing only the best case scenarios. Companies specialising in the positioning of mobile devices are keen to highlight the benefits of their solutions, whilst downplaying the disadvantages and pitfalls that may ensure that their specific technological solution never becomes a commercial reality.

Many of these claims are recycled by writers who may have a less than comprehensive understanding of the underlying technology By only surfing the crest of the waves of new developments and amalgamating these ideas into halcyon visions of the future they often fail to understand the massive technological investment that must be made to achieve the scenarios they describe Often vague descriptions allude to services such as constant online tracking of friends and family or real time voice delivered routing directions at an impossibly accurate resolution (Ground Zero, 2001). The problem can often be not that such services will never be realised in the long term, but that they are not differentiated from the simple LBS functionality that can be anticipated in the short term.

Exaggerated claims are perhaps to be expected when there is a lack of accepted standards or protocols in this industry sector. Most LBS solutions proposed or developed to date have been based on proprietary Application Programming Interfaces (APIs), often only functioning on a single network and a single device. Ericsson have made headway in the field of mobile positioning with the Mobile Positioning System (2001), and the Magic Consortium (Magic Services Initiative, 2001), whose members include Microsoft, Panasonic and digital map data provider Tele Atlas, are attempting to create industry-wide coherence in the field of mobile and in-car LBS. Such commercial ventures hope to see their suggested protocols and suit of APIs taken up by developers and could lead to more services being available on more devices, however it is disappointing to see independent standardisation bodies, such as the WAP forum or Open GIS Consortium (Open Location Interoperability Forum, 2001), being slow off the mark. (The open location services, OpenLS, test bed was not launched until July 10, 2001.)

This paper aims to give an overview of the spatial requirements for LBS to succeed. Firstly from the perspective of identifying the location of the user, then of locating services around the user. These technical requirements and limitations will be compared throughout the paper against some of the more popular claims made regarding LBS It is important not to overestimate new technological developments. As experience with WAP has indicated, when the experience of new technology does not live up to the promise, users are happy to ignore it. If service providers are not careful they may once again experience the feeling that the baby has been thrown out with the bath water.

Locating the user

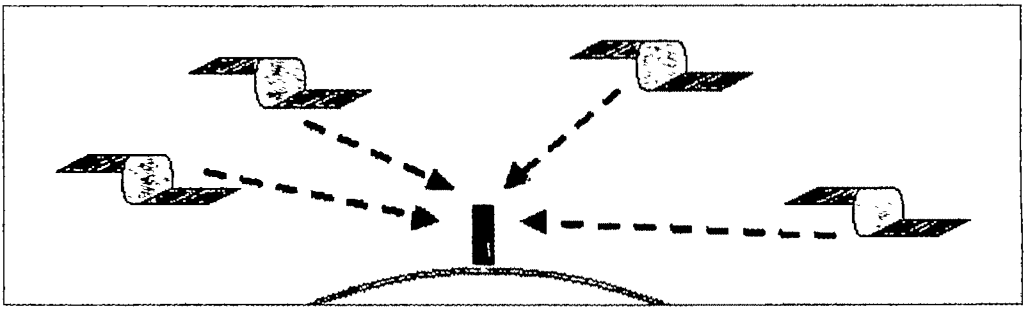
The fundamental requirement of LBS is that the user's location is known. There are several approaches to fixing the user's location employing various technologies and several applications have attempted to achieve the best of both worlds through hybrid solutions. A logical way to classify the techniques is either as terrestrial or satellite based position systems.

Satellite based positioning solutions

There are two existing Global Satellite Navigation Systems and a further proposed €3.2 billion European system called Galileo (2001) Of the two existing systems the awareness and usage of the US Global Positioning System (GPS) far outstrips the occasionally unreliable Russian GLONASS (Borgesson et al, 2001) Since the US military ceased adding deliberate error to the GPS signal for civilian users in May 2000 it is now the natural satellite based solution for use in positioning phones and handheld computers. The Global Positioning System claims a positional accuracy of 30 metres on the ground, 95% of the time, however the 5% of predictions that are wrong by more than 30 metres are likely to occur in the places where there is most need for the system, that is, in the cities

A GPS receiver (a GPS device or GPS chip in a phone) requires unbroken line of sight to 3 or more of the 24 orbiting GPS satellites to attain a positional fix (Figure 1). They are therefore unable to work indoors or in vehicles unless placed close to a window and frequently the 'urban canyons' created by buildings on either side of a street can be enough to prevent any estimate being made It can also often take several minutes for the positional information from each satellite to be received

Figure 1 *GPS receiver on earth's surface communicating with GPS satellites*



cleanly at start-up; a price the techie early adopters tolerate but the mass market may not. The addition of a GPS chip and bulky aerial will also increase the power requirements and size of devices that handset manufacturers are trying to make smaller and more efficient.

There have been several promising attempts to place GPS chips into commercially viable mass-market phones (Benefon, 2001; Garmin Navtalk, 2001). Benefon have launched an entire product range with high-resolution digital map data stored on the client device. In 2000 Ericsson revealed the Ericsson Communicator platform, a large screened PDA/phone/GPS hybrid, however there appear to be no plans to release this promising prototype device Garmin (2001) has approached the problem from the other side, adding phone functionality to its established GPS devices. What all these devices have in common is their lack of impact on the mobile phone market (Angerman, 1999).

Terrestrial based position solutions

Whereas there is unquestionably a leading system for positioning from satellites, there is less coherence in the field of terrestrial geolocation due mainly to the fact that the different countries have different private network operators so no-one can deliver a single integrated system globally Positioning of phones within a cell is well established as it is required for call routing (it is impractical to transmit via every base station to communicate with a single phone, you need to know where it is) and it is from this discipline that terrestrial positioning systems have evolved. A broad overview of the technologies will be given but this cannot be comprehensive, since different network operators often have different approaches to this problem. Since this technology was developed to place which *area* cell the phone was in, rather than the exact *point* at which the device could be found, terrestrial solutions tend to be less accurate than satellite based ones and can only work in places where the phone can get a signal.

Figure 2 *Output from the Visual Net Mobile Network Generating Tool*

Note the hierarchy of cell sizes, the smallest found in the urban areas becoming larger in increasingly rural environments

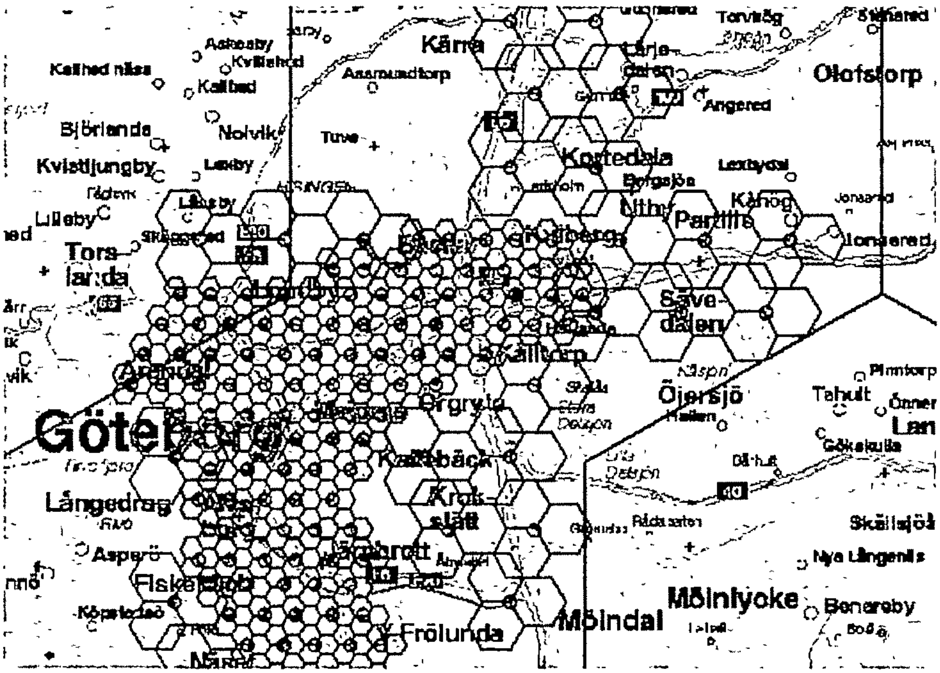
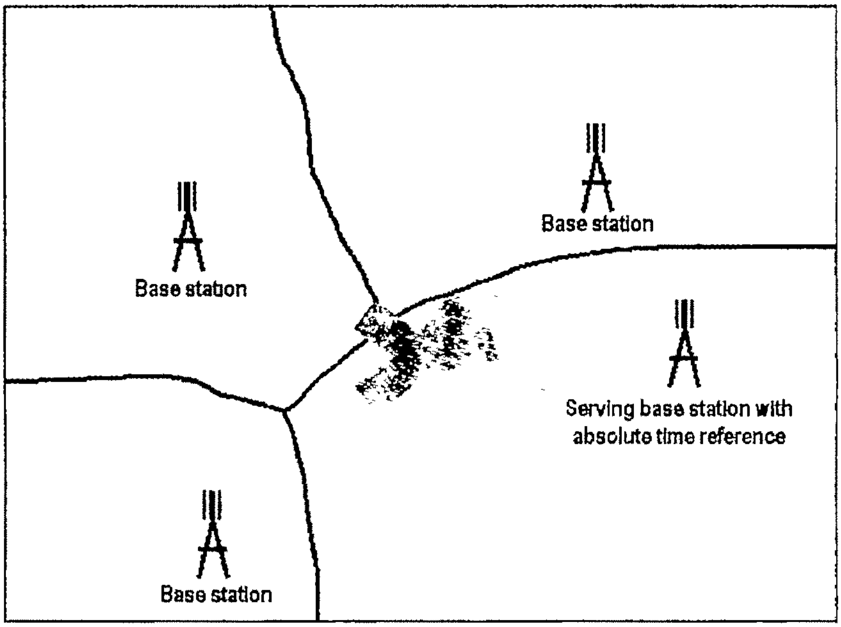


Figure 3 *Output from the Observed Enhanced Time Difference (E-OTD) and Time Difference of Arrival (TDOA) positioning techniques*

The shaded cross shows the potential area in which the user may be located



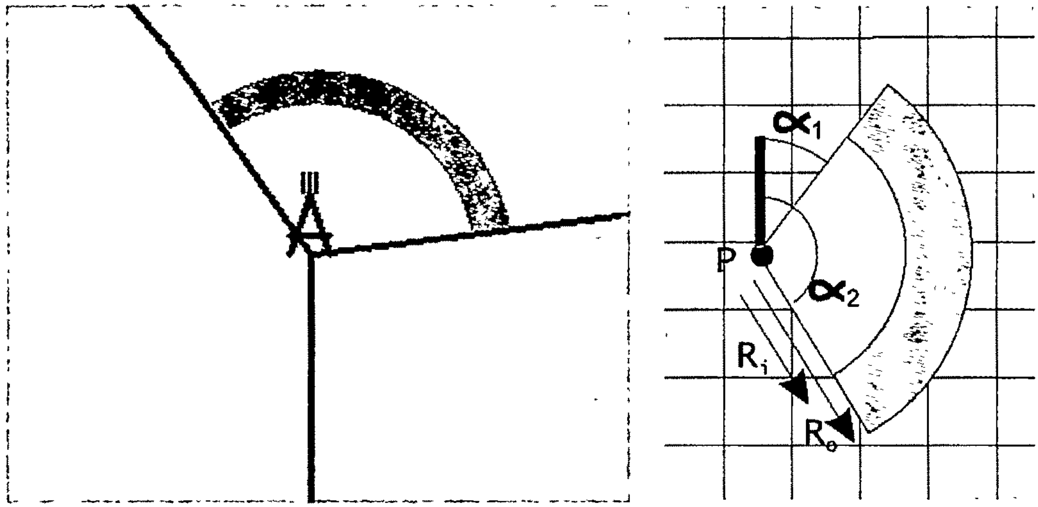
Positioning accuracy is usually most precise where GPS performs worst, in urban areas where the dense network of cells limits the potential area where a phone could be The considerably larger cells found in rural areas will give significantly poorer results (see Figure 2)

Terminal based solutions (Figure 3) see the processing of network signals required for a positional fix occurring on the handset One implementation of this, the Enhanced Observed Time Difference approach (E-OTD), measures the time lag between signals from three or more base stations and fixes the position by calculating the distance from each This technology requires several conditions that do not exist on many networks presently First, the locations of base stations must be known precisely; at present their locations are frequently only recorded to the nearest 100 metres Second, this base station location data must be made available to mobile receivers as frequent network traffic Third, software tools for interpreting this information must be installed either on the phone itself, possibly stored on the SIM, or at the server. Even when all these conditions are met and the handset can ascertain its position, the accuracy is poor, typically 200 metres in urban areas (Swedberg, 1999), and hence unsuitable for many applications for which LBS have been suggested

With network based methods, processing occurs on the server rather than the phone hence there is potential to locate existing phones without the need for modification of the handset or addition of software on the SIM The simplest approach is to define the network area cell in which the user is located (Cell ID) and this can be augmented using timing information to narrow the area in which the user is likely to be (Figure 4). Even with this refinement accuracy is unlikely to be greater than a couple of hundred metres and in rural environments, where network cell radii may be up to 35km, positioning is likely to be very poor. There are other systems that use triangulation of signals from the mobile device to several

Figure 4. *Output from the Cell ID and TA positioning technique*

Graphical representation of locating a Timing Advance (TA) arc within a specific cell (right) and output from the Ericsson's Mobile Positioning System (left). The shaded arc shows the potential area in which the user may be located



base stations (e.g. Uplink Time Difference of Arrival, TDOA) where processing takes place at the server (Figure 3) However, these solutions again require network modifications and available information about the precise locations of the base stations. Accuracy is unlikely to exceed 50 metres under any conditions.

In an attempt to coordinate this varied approach to positioning phones several manufactures have produced systems they hope to see adopted by many network operators A robust solution from Ericsson capable of locating existing phones is the Mobile Positioning System (MPS) (Ericsson developer's zone, 2001). The system aims to use a variety of positioning techniques including GPS and others discussed above, however it can only be as accurate as the positioning technique used by the network operator, and network modifications may be required Hence despite leading the way, the Mobile Positioning System has only been implemented on one network in Estonia (Position System..., 2001)

The Mobile Positioning System is perhaps the most standardised and widely available system but it still meets the same obstacles as any terrestrial positioning technology. The accuracy of the positional fix, discussed previously, is the main drawback. In the case of the MPS this is seen in the variety of shapes that can be returned when querying a phone's location (see Figure 4 for example MPS output). It could be misleading to send a point location when accuracy is poor and the MPS instead sends sections or arcs of circles to represent the user position. These are far harder to work with than the point locations sent by GPS as they may cover large areas on the ground, they certainly prevent 'pinpointing' of the phone location and at the coarsest resolution may only be of use for phenomena that vary slowly over large distances, such as weather reports or regional news.

As well as considering the spatial accuracy, the time period between point sampling can also affect results. Very frequent sampling can generate large volumes of network traffic and be costly. If the record of the user's position is not frequently updated then directions are likely to be poor and the user may cruise right by lots of services they would want 'pushed' to them, but due to a lack of updated positional information, the system would never know. Terminal based solutions such as GPS or Estimated – Observed Time Difference in particular are likely to only calculate their location infrequently, in response to a user request that requires knowing their location (such as a local street map or 'where's my nearest' type query).

These various compromises are being dealt with at the technological cutting edge and are far from resolved US mobile network operators have forced the Federal Communications Commission to alter its original 1996 plan making the positioning of a mobile device to within 100 metres 90 per cent of the time (Enhanced 911, 2001) Phase II starting in October 2001 was supposed to be the start of rolling out geolocation solutions for emergency services and call centres, however the FCC has acknowledged inherent difficulties and has allowed a bending of the time scale and modified its accuracy criteria. Tellingly, new standards demand that wireless carriers' presentations report actual progress to the commission rather than not 'simply what they can't do' (Sugrue, 2001) Operators in Europe, where motivation comes from the potential commercial exploitation as opposed to legal imperative, have been generally slow and tight-lipped regarding their plans for geolocation solutions.

Considering that the weakness of one system is often the strength of another it is unsurprising that many solutions proposed or implemented to date are hybrids of two or more systems. US firm SnapTrack has developed a server-aided GPS solution where the initial fix is provided by the cell information, and the correct satellite configuration can be sent to the phone to prevent it wasting power picking up the faint signals from satellites With the approximate location known, the position is refined by triangulation from the satellites known to be in view With so much speculation about which positioning system or systems will dominate in the future it seems premature to be promising some of the more information-hungry LBS.

Contrasts with in car navigation

Whilst in-car navigation technology is somewhat separate from positioning handheld mobile devices, it is worth considering here because many of the LBS designs have emerged from in-car navigation technology This is somewhat inappropriate since the in-car navigation system is generally a bulky and offline device with large screen and practically unlimited power supply compared to the online, lightweight mobile devices expected to deliver LBS. In-car navigation systems typically calculate their position using GPS and in addition may use dead reckoning (recording the distance and direction moved through the wheels) to enhance predictions. This precise positioning and powerful in-car device allows accurate plotting of the location over high resolution digital maps, stored locally This is a different case from mobile devices that may have to communicate with a server to work out their position and download any imagery they wish to display as a backdrop. When the position is calculated and processed locally users can happily watch their progress through streets in real time and follow audio directions. When the position must be sent over a mobile data network, this volume of network traffic may well be unacceptable, preventing such services from being available to most mobile owners.

Locating the services around a user

Another fundamental problem facing LBS is the need to put a spatial location on stores, services and events that may be of interest to the user. Even if the user's location is known to a few metres it is of little use if the location of services is not known to a high degree of precision. This section will consider the options for georeferencing services and the accuracy of this information.

Data providers

Many tourist information systems claim the ability to find your closest hotels (e.g http //www.all-hotels com), restaurants (e.g. Japanese restaurant guide – http //www.misosoup.co.uk/) or other services. Unfortunately, the company's database of services is likely to be a subset of the actual services on offer in any given region. No company can claim to have the global, current, comprehensive database for all services; instead data providers tend to focus on different geographic areas or types of service such as the London Curry website (2001) It may be disconcerting for users to be walking past services matching that requested to get to the closest one that happened to be listed in the data provider's database

LBS providers will find themselves at the mercy of these data providers whose data may be outdated, inaccurate or incorrectly georeferenced Software exists to georeference a service's location; for example, the postcode can be converted to a geographical co-ordinate reference (Multimap, 2001) In the UK this positions the service at the centroid of that postcode, potentially hundreds of metres from its actual location. The situation is worse in many other countries where the postal code covers much larger areas and many more properties (Ireland for example has yet to implement a postal code system outside of Dublin (Raper et al , 1992). If LBS are only as good as their data then service providers may find that their system is being criticised by users for the poor quality data flowing through the system.

One system designed for web users that gives a glimpse of the volume and quality of the data required is upyourstreet.com (2001). This interactive database stores shops, restaurants, entertainment venues and other services under its 'where's my nearest' product line Whilst at present a service aimed at web users, the pushing of their WAP site suggests that they are keen to enter the mobile LBS market By comparing the postcode of the service with a postcode entered by the user, the closest relevant services can be returned The service is one of the best presented, most accurate and most current available, however its short comings underline the inherent problems with LBS.

Services are listed by postcode and so positional accuracy is ultimately limited by this. Door to door directions would not be available even if the user's location was known to within a few metres. It is also impossible for the database to be completely up-to-date: there are around 100,000 additions and deletions to the postcode database in the UK per quarter Stores regularly change ownership or name, move or close down and significant resource must be allocated for recording these changes. Since there is currently no viable nation-wide mobile positioning solution, the user must enter the postcode of the location they wish to query. Unfortunately, the times when you most need such a service tend to be the times when you are most unfamiliar with an area and hence unlikely to know its postcode. The service is again limited by the positioning of the user. If the location is only accurate to within 500 metres, this is useless for finding a restaurant in major urban areas

Georeferencing web listings

There is however a vast catalogue of services that are freely available, namely the Internet. Increasingly even small private hotels have a website giving their location and prices, unfortunately the information is not yet stored in any organised way. The user's location could be added to Internet searches via a GIS overlay or lookup-tables to transform the dry numerical co-ordinates into a word or words. This is the approach being developed by the Hypergeo Consortium (Hypergeo, 2001; Hypergeo City University, 2001). Selecting the appropriate scale of the search, whether at street, town, regional or national level is critical to the success of LBS. Some services are fairly ubiquitous, such as the nearest McDonalds in urban areas, and associated LBS will require the finest spatial resolution terms (town and street names) in order for them to be included in the search. More exclusive stores and others features, such as archaeological remains, will be more sparsely distributed and require the individual to travel further, hence the spatial range of the search will need to be widened by selecting perhaps town and county names.

Another problem is that alternative or historical names or spellings may be used to reference a service (Jones et al., 2001). In the global context, different transliterations may be used, e g. Peking or Beijing This specific problem has essentially the same cause that data on the Web is not organised in a standard way and library indexing and metadata models have yet to make headway. If this data is to be used as a source for LBS, then it must be queried in a more intelligent way than current web searches

Conclusion

This paper has attempted to highlight some of the technical limitations regarding the positioning of mobile devices and the services they may wish to be made aware of through LBS. The technical situation is complex with many choices of solutions, each with its own characteristics and limitations. Hybrid solutions seem to be in favour, suggesting that the original solutions proposed lack the desired accuracy for positioning of mobile devices for commercial and emergency services. As well as positioning mobile devices, georeferencing the services themselves with sufficiently accurate spatial co-ordinates is a far from trivial matter and there is no simple way to add a spatial identifier to the services available on the Internet. The lesson is that mobile information providers need to examine the lessons of geographic information publishing that have correlated user needs with the spatial characteristics of available datasets. This exercise needs to be done afresh for this new class of LBS applications.

It can be seen that whereas great steps have been taken in the field of location-based services, the reality of a ubiquitous web of ambient information, made available to the mobile user as they move about on the earth's surface, is still a long way from being realised. Suggesting that unrealistic future scenarios are close to implementation will raise the expectations of the buying public. If technology is then introduced that fails to meet those raised expectations the technology could become another mobile telecommunications commercial failure, with major consequences for the putative information society.

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Custom interfaces for advanced queries in search engines

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Those seeking information from the Internet often start from a search engine, using either its organised directory structure or its text query facility In response to the difficulty in identifying the most relevant pages for some information needs, many search engines offer Boolean text matching and some, including Google, AltaVista and HotBot, offer the facility to integrate additional information into a more advanced request. Amongst web users, however, it is known that the employment of complex enquiries is far from universal, with very short queries being the norm. It is demonstrated that the gap between the provision of advanced search facilities and their use can be bridged, for specific information needs, by the construction of a simple interface in the form of a website that automatically formulates the necessary requests It is argued that this kind of resource, perhaps employing additional knowledge domain specific information, is one that could be useful for websites or portals of common interest groups. The approach is illustrated by a website that enables a user to search the individual websites of university level institutions in European Union associated countries.

Introduction

Search engines are widely used by web surfers in order to find information. They work by crawling a portion of the Web, indexing it in a large database, and then providing an interface, normally via a web page, for interrogating that database Using search engines for retrieving information on the Web is often difficult, perhaps partly because of the problem of formulating queries specific enough to find relevant pages. Some information needs, however, are intrinsically more difficult to satisfy due to problems of semantics. A user searching for 'warehouses' may be surprised by the number of pages referring to software warehouses, rather than buildings, returned A search for a more specific word such as 'phenol' will, in contrast, be unhampered by non-chemical uses for the term. There are many websites that already provide sources of information for specific groups of web users, for example one for the chemical industry (www sourcerer.co.uk) that sells access to its own database of UK chemical company products and services. As well as commercial initiatives, professional organisations, commercial common interest groups and other organisations with a website aimed at a collection of people with shared characteristics may benefit from enhancing their website with a facility for helping their target audience to search the Web for topic-related information.

The difficulty of finding information on the Web has been widely recognised, both directly (Schwartz, 1998; Lawrence and Giles, 1999) and indirectly in the production of a large number of tools to aid the process (Ching and Chia, 1999, Bharat, 2000, Wang et al , 2000, Ying et al., 2000), including those aimed at common interest groups (Terveen et al., 1998, Prinz and Grather, 2000). These tools include personal search engines (Chen et al., 1998) which can automatically seek information relevant to the owner's web surfing history but cannot help novel tasks, and those designed to crawl a site in response to a query (Hersovici et al., 1998), but this is a relatively time-consuming approach. Recent trends in search engine design have been driven by the need to identify the pages on the Web most likely to satisfy any given information request. Modifications to the way in which search engines classify pages have also been proposed, for example using the Dewey Decimal scheme (Jackson and Burden, 1999). One development has been an attempt to measure the perceived quality of information on a page by the number of links to it, with the rationale that a page that is the target of many links is more likely to contain useful information than one that none have links to (Brin and Page, 1998). This development may also mean that information that is only infrequently needed will be harder to find.

Some search engines, including AltaVista, also offer advanced search facilities, enabling users to submit complex Boolean queries, but it is believed that relatively few searches actually include these facilities (Spink and Xu, 2000), and the use of Boolean queries for information retrieval can be poor and error-prone (Sutcliffe et al., 2000; Jones et al., 1999). One reason for the lack of use of advanced queries has been suggested to be that they give only minor improvements (Jansen, 2000), although this study was based upon only 15 random queries Some requests can, however, only be answered with advanced syntax, for example site-specific searches. As an example of this, a user wishing to use AltaVista to find maths pages in the Wolverhampton University website would need to submit the advanced query

maths AND host: wlv ac.uk

in order to avoid having the results from other sources swamping those from Wolverhampton. Many search engines now provide a web form based advanced search interface that allows users to specify additional criteria for their search without requiring them to create a Boolean expression, but this is intrinsically less powerful and flexible.

One alternative to standard and advanced searches is to search for information by category in the directory section of a search engine. If a suitable category exists, then this approach should yield only sites that are relevant to the information need If a particular piece of information is being sought that may or may not be in any of the category sites, then Google offers the facility to search inside the sites in any category, giving a similar effect to an advanced search with AltaVista that specifies the host. Google even allows searching in every site in a whole category, a very powerful feature. As an example of this, a search for 'Metallurgist' in the Google UK university category would return (on several pages) one or two matches from each university which had a website containing this word. It will be demonstrated, however, that the interface presented can be customised to include additional useful information and to make certain types of searching easier.

The vacuum formed by the gap between the requirement for complex queries and their lack of use has allowed tools that provide a simple substitute interface to be developed Two examples use semantic disambiguation techniques to automatically create advanced queries which are, in general, more successful than the unprocessed originals (Stibel, 2000; Moldovan and Mihalcea, 2000). This approach essentially gives indirect access to more powerful searches to those who would not otherwise use it. It is aimed at the general information needs, but it is also possible to create a simple interface targeted at specific types of queries, for example site-specific searches. Such a tool could be provided, for example, by an interest group that wishes to create an information resource website and expects that its user base would have a need to search a common set of websites Many such sites already maintain a list of useful links, and this would be a logical extension to that. Indeed, some sites already provide specialist search facilities (Thede, 2000) but this represents a level of technological complexity and expense that would rule it out for many groups.

In order to test the concept of using automatically generated advanced queries to create a portal for a common interest group, a website at http://www.scit.wlv.ac.uk/~cm1993/eusearch/ was created to aid academics to find research partners in unknown disciplines and in universities throughout Europe Such a site can have two potential advantages making the formulation of appropriate queries easier; and being able to include additional, target-user specific information Both of these aspects will be discussed and the site subjected to an initial evaluation with a tool from the discipline of human-computer interaction that is used by developers for theoretical testing of interfaces.

Site-specific searching

The potential pitfalls from using standard approaches will be illustrated with an example of a similar piece of information to be extracted from a collection of sites The example is to extract the e-mail address or other contact information for five academics from different universities in the UK with a research interest in information systems. In order to solve the problem, a search engine may be useful if used as part of an appropriate strategy. Ideally, the user would enter the search text 'information systems research UK' and the search engine would return a list of links to the web pages of all information systems researchers in the UK In tests, AltaVista, HotBot, Yahoo! and Google returned a variety of pages related to information systems, mainly to national organisations and websites. Only Hotbot returned a directly useful link, to the Management and Information Systems Research Group in the University of York. In practice, therefore, the lists of pages returned containing all or most of the terms 'information', 'systems', 'research' and 'UK' provided an imperfect solution to the problem. A fundamental information retrieval problem here is that there may be many pages that only contain the information that they belong to a UK university implicitly from being part of its website, rather than explicitly by containing the words 'university' and 'UK' in the text of the page The query text may also be elsewhere on the site, may be scattered throughout the site, or may even not be present at all The directory structure of search engines can be used to narrow down searches before entering the search terms, in an attempt to circumvent this problem. A search from the Yahoo! Directory category for UK Colleges and Universities for 'information systems research' did not yield any academic or research group pages because the search does not cover the majority of the websites. Google does attempt to search a large part of each academic site in its category search, and so it was also used. A Google search of the category for UK Colleges and Universities for 'information systems research' did yield a large number of useful links Google returned only one or two matches per site, which enabled it to return several universities per page It does not allow selection of the order in which the universities will appear, however. Google could also be used to search each individual site by selecting their category first.

A third approach is to find a listing of UK university websites and then to use the advanced search facility of an engine like AltaVista to search each domain specifically. An example of this would be

host:warwick ac.uk AND information systems research

This is clearly a more complex strategy, requiring the knowledge of advanced syntax It is essentially equivalent to the search offered by Google by first selecting the university from a category and then choosing the option to search within the selected website. This type of search will form the basis of the custom interface discussed below, and would be particularly useful for any categories not covered by Google or by any other search engine offering the same category search functionality This approach may also be applicable to other less clear-cut uses of advanced syntax when information about the context of the query can be inferred by the presence of the user at a special interest host site As a simple example of this, a fan or club site for a football team may have an interface which automatically adds 'AND NOTsoccer' to all user queries

Search engine category listings normally contain a brief description of each site suggested to the user, often with the text drawn from the pages targeted. Sometimes this information will not be enough to enable searchers to decide which sites to choose. They may, however, require specific information that is not provided, such as geographic location, product types or company sizes in order to make the choice. If such a need were to be identified as common to a number of people, then it would make sense for it to be provided by the search engine at the point of need, as part of the company listing in the directory structure. No freely available commercial search engine, however, has done this yet This is perhaps a reflection of the difficulty in ascertaining the information that would be most pertinent in any given category, and over a sufficient range of categories to make a marketable additional facility This does, therefore, make available an alternative strategy for an interested third party: to provide their own interface to a search engine, which can include the necessary additional information. This is technically possible because search engine queries are HTML constructs, and so can be formed in any web page and passed on to the search engine. In fact many search engines provide the HTML for a search box themselves and encourage visitors to add it to their sites. The type of third party that may benefit from this approach would be an interest group that identifies common information retrieval needs which search engines are not able to easily satisfy The relationship here would be a symbiotic one, because the queries submitted would be generating hits on the search engine and, therefore, producing advertising revenue. In fact AltaVista, as part of its affiliate network, will pay users to add the HTML for a search query box to the search and so may be willing to pay the portal for this facility. There are already many portal sites that attempt to collate information for their user base and provide aid in web navigation. One method has already been suggested to automate this process in the face of its time-consuming nature (McCallum et al., 2000), but the approach described here is dealing with a related problem through a completely different technique

A test case: the academic partner website

As a test case, a web portal designed to enable the speedy selection and searching of university websites from 31 European Union associated countries was created and will be examined. It also provides pertinent information to aid site selection and automates the task of constructing Boolean queries. University websites tend to be well covered by AltaVista (Thelwall, 2002) and for this reason seem to be a good target for this approach. A similar website has been created before for the UK to enable industry to have access to information about university research (Gomes et al , 1997), but this project involved the construction and maintenance of a database, a relatively expensive method. The website was constructed both to fill an information need and to provide a demonstration of the ability of third parties to provide an added value service to specific interest groups, based upon existing commercial search engines The target group for the site was university academics and the need was of finding other academics in highly rated research institutions in the EU for specific disciplines, potentially ones unknown to the searcher. This is the kind of need that can arise, for example, when putting together a consortium to bid for EU funding under a research budget such as the Fifth Framework Programme (Europa, 2001). This source of funding encourages both multinational and multidisciplinary co-operation, leading individuals and teams wishing to submit a bid to seek out others in unknown disciplines and countries Websites are often not designed in a way that aids all users (Ellis et al ,1998), and finding information on academic websites is known to be difficult (Gullikson et al , 1999), so this is a task that would benefit from help. In order to identify through a web search suitable academics the following pieces of information would be useful.

1. The names and domain names of university level institutions in the target countries
2. An indication of the relative research standing of each university in its own country.

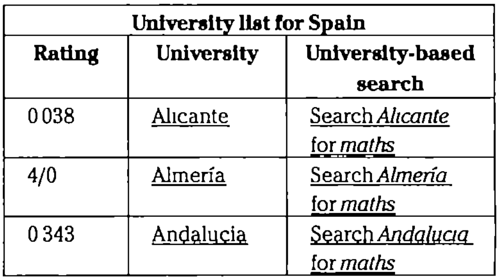
The academic partner website attempts to provide both these pieces of information in an environment seamlessly linked to AltaVista so that the universities can be searched individually. It also provides a link to AltaVista's translation page to help searches in countries where the language is unfamiliar to the user.

There are many websites that give lists of university home pages in various countries, including Yahoo[1] and Google. In order to use search engine advanced syntax, however, it is necessary to know the domain names that host the majority of web pages for any given university The team working on the academic partner website collated lists of university websites in EU-associated countries from various sources and used AltaVista to count the pages hosted on each one Any university with few pages was followed up, often resulting in the discovery of a change of domain name, or a second site hosting more pages than the official site. As a result, a more useful list of domain names was produced. This was a time consuming operation, with over 700 sites to check.

The second requirement, an assessment of the relative research standings of universities, is much more difficult to satisfy. In the UK there is an official research assessment exercise performed by the government, which can be used to construct useful general research quality indicators (Elkin and Law, 1997). Such exercises are, however, not universal internationally. An alternative measurement has been created by Ingwersen (1998), the *Web Impact Factor*, which is based upon counting links to a site and dividing by the number of pages hosted in the site. It has been shown that this measurement correlates strongly with the accepted research ratings in the UK (Thelwall, 2002). For example, counting the number of UK university web pages outside (say) Oxford University that contain a link to any Oxford University web page, and dividing this by the total number of web pages in the Oxford site gives a figure that it is useful to compare with other similar figures It was decided to provide official research ratings for universities in countries where they were available, but to provide this calculation, accompanied by an appropriate disclaimer warning of their potential lack of reliability, when they were not.

The website home page provides the user with a search text box similar to that of a search engine, but with the additional option to select a country upon which to focus. Submitting this page does not return a set of results but a table of information about the universities in the country chosen. This includes the name of each university and their (normally estimated) research ratings. The table also contains a link for each university that is an appropriately formulated advanced AltaVista query to search the specific university website for the terms entered on the previous page. A single click is enough to submit the query to AltaVista and load it into a new browser window For example, if the term 'mathematics' had been entered and Spain selected on the first page then clicking on the University of Seville link would be equivalent to submitting to AltaVista in a new browser window the query: mathematics AND host:seville es. It was decided to use AltaVista instead of an equivalent Google category search, simply because the AltaVista approach is slightly more generic, with Google needing to have an appropriate category set up in order to use its site search feature.

Figure 1 *An extract from a site page after a maths query has been submitted for Spain It shows ratings, links to homepages and links to trigger AltaVista advanced site-specific searches for maths*



University list for Spain		
Rating	**University**	**University-based search**
0 038	Alicante	Search *Alicante* for *maths*
4/0	Almería	Search *Almería* for *maths*
0 343	Andalucia	Search *Andalucia* for *maths*

The aim of the website, in summary, was to aid both the selection of universities and the subsequent searching within the chosen sites

Interface analysis and discussion

The website will be compared with an advanced search engine and a directory based search service, in the context of seeking unknown academics in other countries. The basis for comparison will be twofold: how likely is it that the method will be successful in meeting the user's need, and how easy the interface is to use. This second point of comparison will be attacked in a relatively abstract fashion, the interest being in the approach used rather than the specifics of the actual implementation.

One way in which the academic partner site is more satisfactory than the comparators is in the provision of the additional, task specific information relating to university research ratings. If this is critical information for the task, then it may be the case that the partner site is the only realistic web search-based option. It may, however, be possible to combine the other search strategies with alternative methods of identifying research standings, for example consultation with peers, other websites, or official offices for international affairs. These options would, however, add to the time required to complete the task.

The academic partner site is less satisfactory than the comparators in transferability of skills. A different website, no matter how simple, requires some time to learn and master. A user already familiar with standard search and directory services would, therefore, be forced to undergo new learning if they were to use the partner site; time that would be producing less transferable skills than if a generic search site were being used. It would also, of course, be necessary to find the site to start with, a factor that is difficult to account for in comparative studies.

Comparison with AltaVista

Searching by university website in AltaVista using the advanced search syntax amounts to manually entering the queries for each university, rather than having them automatically created by the site. For those unwilling to learn the necessary syntax, or who do not know of its existence, the partner site makes this type of search possible. Its advantages over AltaVista for those who could use either method are in the provision of the domain name information for the universities in the chosen countries and in the automatic creation of the queries for each institution. The partner site creates a page of clickable links to the search results pages, so that the query terms only need to be entered once and the domain names and advanced syntax do not need to be entered. To activate successive searches all that is needed is to click the query links in turn, closing the new browser window created by each link once the search has been finished. One simple way to compare two methods is to count the number of keystrokes and other similar actions that are required to complete the actions, thus modelling the difference in time for an expert user to execute the tasks without error (Card et al., 1983). This does not, however, include any attempt at quantification of the difficulty or length of decision-making processes that using either method would entail. Table 1 shows an analysis of the actions needed to do this, compared with those for a user entering the queries manually, referring to another website in a separate browser window for the domain names and using the browser 'back' button intelligently to minimise the total number of actions needed. The task is the execution, but not following up, of queries for the first five listed Spanish universities, with the query 'Maths'.

Partner site

Starting with partner site loaded:

- type 'maths', select Spain from the country list and click on the submit button.

Next, for each of the five universities:

- click on the search link to activate the search in a new AltaVista window. Next on a link in the AltaVista results page to simulate finding the information and then close the window.

AltaVista direct use

Starting with AltaVista in one window, and in another window a list of domain names for Spanish universities:

- type 'maths AND host:.ua.es', then click on the submit button. Next click on a link in the AltaVista results page to simulate finding the information and then click on the back button to get back to the AltaVista results page, which contains the original search syntax and can be used as the basis for the next university search. (21 keystrokes, 2 links, 1 back)

For the next university, www.ual.es:

- swap windows to identify the next domain name, eg www ual.es, swap back to the AltaVista page, click between the 'a' and '.' of ua.es to insert 'l' and click to submit the new search (this is the quickest way to modify the query). Next click on a link in the AltaVista results page to simulate finding the information and then click on the back button to get back to the AltaVista results page. (1 keystroke, 1 click, 2 links, 1 back)

The previous step must then be repeated for www.uia.es, www.uab.es and www.ub.es.

Table 1 *A comparison of the partner site and AltaVista in terms of user actions to search five Spanish universities*

Action	**Partner**	**AltaVista**
Press Key	5	28
Click browser back button	0	5
Select option button	1	0
Click web page button or link	11	10
Click to close browser window	5	0
Click to swap windows	0	8
Click in text or click and drag to select query text (to be deleted or overtyped)	0	4

From Table 1, the number of actions in AltaVista is much higher. It should be noted that these actions include entering correctly formatted syntax, a cognitively more challenging exercise, even when practised, than clicking a mouse button.

An experienced user may attempt to recover unsuccessful searches by combining search terms with additional advanced syntax in order to get a more precise query, and could do so in the first search results page returned by AltaVista, whichever approach was being used, although this adds an extra step to the process.

Comparison with Google Web Directory

The comparison that will be made here is with the searching of individual sites by Google, rather than using the national university directory global search option to search all Spanish university sites with one query. This latter type of search would require fewer actions, but is excluded on the grounds that it does not allow the pre-selection of sites: the results appear in an order uncontrolled by the user.

The partner site interface does have a slight measurable advantage over the Google directory search in terms of the number of actions required to operate it. This stems from the fact that for each query, the university must be selected from the national university list directory and then the keywords must be typed in. This gives two click actions and one typing action per university, whereas the partner site only requires one typing action and one click for all universities, in addition to a single click for each individual one. The difference between the two will be minimised if the query term is copied and posted rather than retyped from scratch in each Google university entry. Table 2 shows a comparison between the two for five Spanish sites. This is, in fact, only a theoretical comparison because, at the time of testing, Google only had a separate category for six of the Spanish universities, three in the English language category and three in Spanish. In fact, none of these were from the test set and so the study is conducted under the assumption that such categories will be added, or that the same functionality will be added to other search engines. Google does have a single very large page listing many higher education institutions in alphabetical order, but this did not give the necessary national identity information to make it useful, and would still have been unwieldy if it had

Google

Starting with the Spanish Google Web Directory category for European universities (the fairest possible starting point since Google has separate language categories):

- Select the country España and click submit, then click on the University of Alicante category, type 'maths', select the word and type control-C to copy it (for later use) and click on the submit button
- Then click on a link to simulate a search and click on the back button twice to return to the España page.

Next, for each of the four remaining universities.

- Click on the university category, click on the query box and type control-C (to paste the query), and click on the submit button.
- Then click on a link to simulate a search and click on the back button twice to return to the España page.

Table 2. *A comparison of the partner site and Google Directory in terms of user actions to search five Spanish universities*

Action	**Partner**	**Google**
Press Key	5	10
Click browser back button	0	10
Select option button	1	0
Click web page button or link	11	11
Click to close browser window	5	0
Click to select a text box	0	5

If the user wishes to search universities in more than one country, then in the partner site this can be achieved in three actions: pressing the browser 'back' button from the current country query screen; clicking the name of the new country and then clicking the submit button. It is not much more difficult in the Google Directory, since it has a category for education and a subcategory for Europe. The multi-lingual variations, would, however, be a slight confusing factor.

Conclusions

The study has clearly identified that a website offering a specialist interface can be measurably superior in some aspects of usability to general search engine strategies This finding, essentially that less actions need to be performed on the bespoke site for multiple searches, is in addition to the extra information provided, and makes a strong case for the efficacy of such a solution It would be rash to declare, however, that the approach will be efficacious for all users or types of query. Many different models have been applied to information retrieval (Beaulieu, 2000), highlighting the fact that different information needs may benefit from a variety of approaches. The claim that interest groups may be able to aid searches by users of their site by automatically constructing advanced queries, with additional terms to clarify context, is given credence by research which has shown that semantic disambiguation techniques (Stibel, 2000; Moldovan and Mihalcea, 2000) and the opportunity to focus a search after submitting keywords by choosing potentially relevant domains can be fruitful ((Ben-Shaul et al., 1999). In support of this, one search engine has developed apparently similar logic to automatically suggest additions to a search to clarify any ambiguity, constructing a complex combined query (Gallagher, 2000). It may well be the case, then, that the approach described here is not only useful for site specific searching, as demonstrated, but also for subject-related searching. Further research is needed with end-users in order to ascertain whether the approach is genuinely viable and useful.

The biggest disadvantage for any given site constructed for a specific user need in the way that the academic partner site was, from a computer-human interaction point of view, is its lack of universality. This is apparent from a task-centred point of view in the need to first identify the appropriate site when its services would be required. It is also evident in the fact that the skills used to execute its searches would be less transferable than if a standard search engine strategy were to be used The analysis has also not proved that the site is actually effective in practice because it has not included experiments with real users. The point was, however, to demonstrate that the strategy was capable of showing significant gains, at least in some areas, over existing tools. The move towards increasing automation of tasks, as provided here, is the type of facility that is a progressive trend in history (Bhavnani and John, 1998), and so, in general terms, can be seen as an almost inevitable development If the results of future testing with end-users are positive then the technique may be useful for any interest group whose membership is expected to use specific types of searches that would benefit from advanced search syntax and/or additional supporting information.

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The five maxims of project satisfaction

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Software development projects are notoriously poorly managed. It is not uncommon for projects to be delivered late and over budget by a factor of 50% to 100% – in fact, in some software development organisations it is expected or even regarded as normal. The paper aims to fuse traditional project management theory with customer satisfaction principles most often applied within marketing disciplines. By thoroughly understanding the motivations of stakeholders and adopting a customer-focused approach, a project manager can begin to effectively manage expectations and reduce overall stakeholder dissatisfaction

Stakeholders as customers

Much has been written about stakeholders – from basic definitions of the various stakeholder constituencies to the psychology of stakeholder management. However, the literature mentions very little about the fact that stakeholders are essentially customers of the project management effort.

For the purposes of this discussion, the customer is the collection of stakeholders involved with a project including users, sponsors and champions. Customers can be internal or external to the organisation or, in most cases, both In short, the customer specifies what is needed from the development effort, uses the end product or 'pays for it'.

Why projects fail

In July 2001, *The Guardian* reported that the British government had wasted 'more than £1 billion in high profile government IT failures' since the mid-1990's (Miller, 2001). From the delayed and scaled back Denver International Airport baggage handling system to the failed automation of the London Ambulance Service system, the popular press has been littered with reports of large-scale software project failures Post-mortem accounts of project failures tend to blame both poor management and technological shortcomings. Citing a 1995 KPMG study Glass (1998) highlights seven primary reasons for project failures:

- project objectives not fully specified;
- bad planning and estimating;
- technology new to the organisation;
- inadequate/no project management methodology;
- insufficient senior staff on the team,
- poor performance by suppliers of hardware/software;
- performance problems

Glass concludes his study of 16 case examples by further citing the KPMG research to reveal that companies are looking to mitigate project risk by:

- improving project management;
- conducting feasibility studies;
- get users more involved;
- seeking external advice.

Despite the rank of third on the list, the author contends that user involvement is the single most important element of project success. Ultimately, software projects fail because the delivered product does not live up to the expectations of the customer. To ensure success, project teams must go beyond traditional requirements engineering methods to thoroughly understand and appreciate the customer's motivations Only then can software be developed that meets and exceeds expectations.

The five maxims of project satisfaction

The conceptual framework for the five maxims of satisfaction (Boyd and Boyd, 1998) was developed through the study of more than 30 years of collective experience in technology, business planning and marketing research. Boyd and Boyd developed the five pillars of satisfaction as a framework to guide small businesses through basic planning and decision-making exercises. The author soon realised that the five maxims are universal to all satisfaction-related problems – particularly those revolving around project delivery and stakeholder management. The concept has been tested and refined for the past three years in actual business environments.

Regardless of project size, scope or duration, the author believes that there are five fundamental maxims to be followed when delivering the projects. These 'five maxims of project satisfaction' are:

1. deliver the product that the customer desires or needs;
2. deliver quality consistent with the price,
3. deliver the project in a timeframe the customer desires or needs;
4. deliver the desired degree of feedback that the customer desires;
5. have a system of conflict resolution that is fair to both the customer and the development team

With each of the above satisfaction maxims, the project manager must beware that the customer's explicit and implicit desires and the actual needs are often opposed. A good project manager will learn to interview the customer thoroughly to ascertain both the expressed and hidden desires and needs Through the proper management of the five maxims, the project manager will be able to ensure project success.

Deliver the product that the customer desires or needs

To ensure project maximum customer satisfaction the project manager must have a thorough understanding of the customer's wants and needs and act to deliver the level of innovation, technology, design and features that the customer desires This understanding can come from a variety of sources. In small organisations, it may be intuitively self-evident. In larger organisations, or on larger projects, the project manager may wish to deploy both qualitative and quantitative methods to identify and prioritise salient issues. However, it is often important to go beyond standard requirements gathering exercises to determine the customer's motivational drivers.

Delivery quality consistent with the price

Price and quality cannot logically be separated. Using a generic example, a customer looking to purchase a 69 pence hamburger is expecting a different level of quality and service than a customer purchasing a £6.90 burger.The same can be said of software development projects, a £30,000 content management system should come with a different set of expectations than a £900,000 system

Deliver the project in a timeframe the customer desires or needs

Timeframes can be based on real events, such as an absolute need for delivery by a 'drop-dead' date, or be based on an arbitrary date to be used as a goal. A project manager must understand the true nature of a deadline to properly manage the client's expectations. The technical lead on a project, or the person responsible for task estimation, may 'pad' the schedule to allow for both internal and external delays Knowing this, the project manager may then significantly reduce those estimates (resulting in greater padding in the future), thus presenting an inaccurate schedule to the customer. As a result, customers have often had negative experiences with late delivery of projects, and there is a similar tendency on their part to 'pad' the drop-dead date to allow for such slippage. As a result a project schedule can be misstated by several orders of magnitude.

Even when project schedules are properly estimated, there are many other reasons for delays. For instance, project managers have a tendency to delay difficult items that are not on the critical path Thus, the last 10% of the project is spent addressing those difficult issues leading to schedule overruns (Goldratt, 1997).

With a clear understanding of the business and psychological drivers behind deadlines and milestones, a project manager can begin to navigate through common 'timeframe-related' satisfaction pitfalls.

Deliver the desired degree of feedback that the customer desires

Some customers want to be part of the development effort at every stage of the project, requiring frequent updates and a high degree of involvement in the decision making process Other customers feel that they are paying for the project team's expertise and only want to be informed when something goes drastically wrong, or when a major decision is needed. Most, regardless of their level of involvement, want to critique and alter the project after the project team considers it finished. Communication procedures and expectations need to be set early in the project by both the customer and the project manager.

Have a system of conflict resolution that is fair to both the customer and the development team

During a project, conflicts will arise. It is the project manager's responsibility to manage the negotiations surrounding the conflict in such a way that the outcome is fair to both the development team and the customer. The project manager is an advocate for both the development team as well as the customer. Both must be confident that the project manager is acting in their best interests. If that is not possible, both must be assured that the project manager is acting fairly.

To minimize pressure to represent the team perspective, the project manager should have heated meetings and telephone conversations with the customer away from the development team Away from an audience, the customer will be less likely to assert authority over the project manager

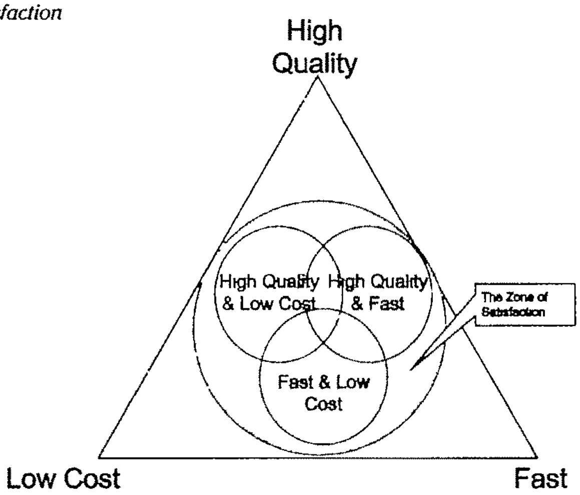
Finally, a balance of costs most be recognized The cost of lost business from dissatisfied customers must be balanced against the cost of unplanned (often free) work needed to resolve customer complaints. The cost of unplanned work for one customer will eventually be passed along to every other customer of the software development organisation – in terms of additional staffing costs or other project slippage.

Managing multiple maxims

Obviously, a successful project requires the project manager to figure out what is important to the customer. An old adage in technology sales suggests that all projects consist of a price, quality and timing element – the customer can only pick two. In the real world, customers are not able or willing to forego one of these crucial elements – nor should they have to without a valid understanding of the tradeoffs.

Expanding upon that (now) cliché, the project manager must determine what combination of all three elements will deliver the

Figure 1 *The zone of satisfaction*



highest degree of satisfaction to the customer. Somewhere within the 'zone of satisfaction' lies the optimal level of satisfaction.

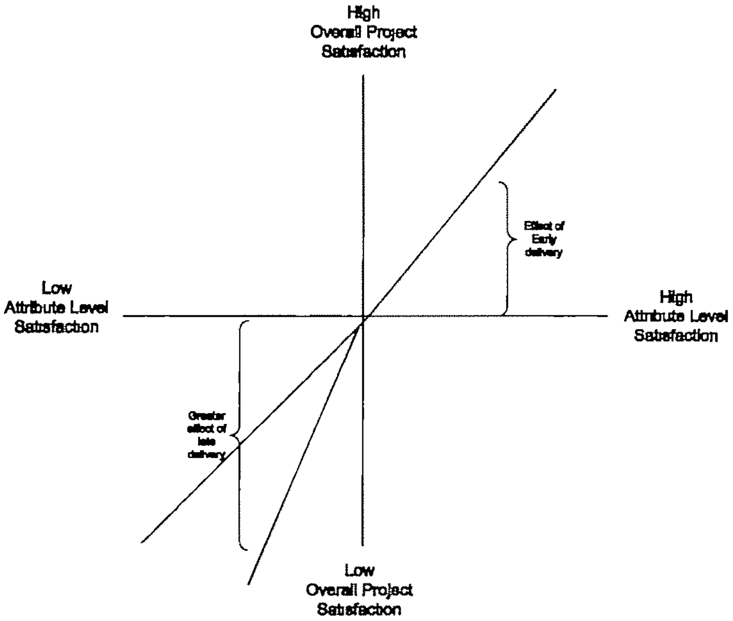
If the customer is price and quality sensitive, they will operate in the upper left part of the triangle. Time and cost sensitive clients will operate in the lower part. Time and quality sensitive clients will operate in the upper right portion of the triangle.

Project satisfiers and dissatisfiers

Understanding that project success depends on determining where the customer falls within the zone of satisfaction is not an easy task. Both satisfiers and dissatifers have an effect on overall satisfaction and thus where in the zone of satisfaction a customer lies A satisfier is something that, if achieved, will have an effect on the customer's satisfaction. A dissatisfier is the opposite – where if it is not achieved, it will negatively effect the customer's satisfaction. It is important to understand that a satisfier is not necessarily a dissatisfier and vice versa. There are drivers of satisfaction that, if delivered well, have minimal impact on overall satisfaction However, if those same drivers are delivered poorly, there may be a significant negative impact on overall satisfaction.

Satisfaction or dissatisfaction on the same element can have a disproportionate effect on the customer's overall satisfaction. The easiest example to illustrate this point is project delivery. If a project is delivered a week early, the customer may be moderately happy. On the other hand, if the project is delivered a week late, the customer will be disproportionately unhappy. In a situation where the project delivery date is arbitrary, the deadline may be a project satisfier, meaning that the client would be happy if the project were delivered on time, but not disproportionately unhappy if the project were delivered late. When pressed with a drop-dead date, features and functionality may have to be negotiated, or left out causing the client to be dissatisfied. So, if the project manager naively assumed that the deadline was more important than functionality, the project manager may cut out features so that

Figure 2 *The disproportionate impact of a 'dissatisfier' on overall satisfaction*



the development team can make the delivery date. Since the deadline was arbitrary in the first place, and did not rely on any business need, the customer may be more upset about the loss of functionality. Thus, the satisfier of on-time project delivery is over-shadowed by the dissatisfier of reduced functionality.

When accounting for satisfiers and dissatisfiers, the impact of a particular element on overall satisfaction is not linear. In previous work on patient satisfaction and repurchase intentions it was noted that this relationship is both linear and 'asymmetrical' (Mittal et al, 1998, Mittal and Baldasare, 1996; Boyd and Baldasare, 1997).

Unfortunately, as many project managers soon find out, explicit and implicit indicators play a significant role in being able to accurately tell what is important to the customer. In the case outlined in Figure 2, for political reasons, the customer may have been unwilling to clearly state that the deadline was unimportant – leaving the project manager to her own devices to determine if it was driven by a business need.

The impact of staffing on customer satisfaction

In recent years, much has been written about customer satisfaction from a financial and marketing perspective. Unfortunately, from a staffing point-of-view, the customer is often ignored for considerations such as the deployment of known (or cutting-edge) technology, or business concerns such as project efficiency and staff utilisation

Currently, there are several software development-staffing models used in the modern organisation including in-house or external resources. Choosing the wrong staffing model can have a disastrous impact on customer satisfaction

In-house development

Organisations staff in-house software development teams for long-term, or on-going, development and maintenance efforts. This approach is cost-effective as long as projects ebb and flow in a steady state manner However, the stream of new projects rarely ebbs and in-house IT departments often have a huge backlog of projects that they are unable to staff.

In some organisations, heavy pressure is placed on the development and completion of marquee projects and lower profile projects are passed over when staffing. From the customer prospective, this 'high-profile' project focus can be very frustrating, creating the illusion that the IT department does not do anything (at least not to serve their needs). To add insult to injury, chief technical officers often have no reason to consider customer satisfaction in decision-making. In fact, there is often an incentive not to. Software development performance, if measured at all, is often measured through the use of statistics such as mean time to failure (MTTF) and errors per lines of code, not on customer satisfaction scores

Projects that require the use of new technologies can be a godsend to in-house staff. New technologies give in-house programmers the opportunity to develop new skills. However, without prior experience the organisational learning curve can prolong the project time-line and lead to architectural mistakes that add cost to the project

Project outsourcing

Purely from a cost perspective, staffing long-term projects and IT programmes with internal resources makes sense However, for one-off and short-term projects, IT decision makers often turn to external agencies

Maister (1993) identifies three key benefits that clients seek when outsourcing a project. 'expertise', 'experience' and 'efficiency'

Expertise firms

According to Maister the expertise based practice focuses largely on 'brains' type work that seeks to resolve previously un-tackled problems. Expertise firms hire the best and brightest out of the top schools and generally engage in custom solutions to complex problems that have never been solved before Because of the custom nature of each project, this approach to project staffing is not considered cheap

Experience firms

The experience based practice focuses on certain types of problems that they have previous experience with – not on intellectually 'bleeding edge' work. The experience based practice uses the knowledge it has gained on other projects, either in the same industry or problem area and applies it to the problem at hand

Efficiency firms

The efficiency based practice focuses on delivering the same solution over and over again, learning how to do it better and faster each time. There are different types of efficiency-based practices, including systems integrators and offshore development agencies.

The systems integrator approach

The system integrator (SI) specialises in a core technology or group of technologies and generally develops skill sets around specific problem areas. These firms are good if a company needs assistance with the configuration and installation of a commercial off the shelf (COTS) software package that requires minimal customisation If massive customisation is required by the customer's needs, the SI may not have the depth and breadth of resources to scope the modifications, or the expertise to re-engineer the COTS package.

COTS solutions are attractive to many organisations because the initial price tag seems several orders of magnitude cheaper than a completely custom solution. However, the customisation that is required to make COTS systems work often will cost several times the licence fee. The trade press reports that content management systems can cost from two to three times the software licence fees to develop, integrate and adopt into an organisation (Boslet, 2001) Off the record, some industry insiders lament that certain types of COTS systems can cost six to eight times the licence fee to integrate

Offshore development

Offshore development agencies are cropping up all over the world. Croatia and India have highly educated software engineers that will work for pence on the pound compared to their western counterparts. In many cases, offshore development is an attractive way to minimize growing project costs. Unfortunately, offshore arrangements often add several degrees of complexity in terms of project management and managing customer expectations. For instance, there may be communication issues stemming from language and geographic barriers. Teams may be working in different time zones and with different communications and workflow technology.

The impact of staffing models on satisfaction

Generally speaking, an offshore software development agency will deliver projects at low cost, systems integrators will operate relatively quickly and expertise and experience consultancies will offer highly customised (high quality) solutions. Once a project manager has determined the key drivers of satisfaction, and where the customer falls within the zone of satisfaction, they can choose the best staffing solution for the problem (Figure 3).

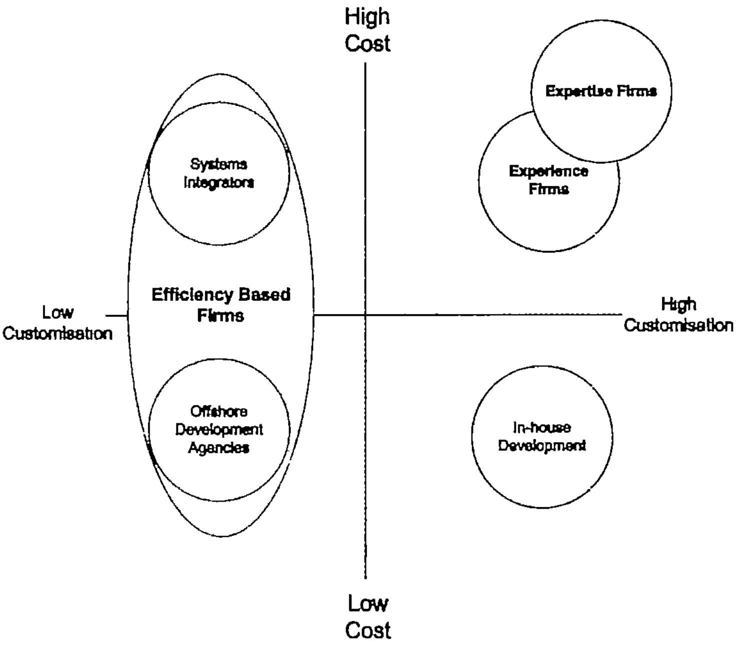
If cost is the driving factor on a low customisation project, then an offshore agency will suffice. Alternatively, it would be a major mistake to hire a brains firm to complete the work. Similarly, it would be an equally major mistake to hire an offshore agency to engage in highly customised solutions for which the client is expecting to pay handsomely.

Unfortunately, choosing the correct staffing model to optimise satisfaction is not always straightforward. Every client and project will have a different set of drivers, potentially requiring a new or different staffing solution.

Discussion

A software development project generally addresses one of two basic needs within an organisation – either it serves to address a functional imperative, or it adds a competitive advantage. That is, the project delivers a core functionality that an organisation absolutely must have from an infrastructure perspective (such as telephony or LAN systems) or it is intended to give the organisation an advantage over competitors.

Figure 3 *Optimal staffing models by selected project drivers*



For each type of project, the five maxims of project satisfaction may be influenced differently. For instance, the replacement of a company's telephony system probably does not warrant a high degree of customer involvement The customer just wants it done quickly and quietly without notice from the rest of the organisation. Whereas a multi-million pound e-commerce project with top-line and bottom-line implications has different time and price sensitivities. It also warrants a different level of customer involvement, from both a requirements and conflict resolution perspective.

Clearly, many factors influence project satisfaction – from the five maxims to project staffing. With a full understanding of the effect of satisfiers and dissatisfiers on stakeholder satisfaction, the project manager can begin to effectively manage customer expectations as they focus on the actual tasks of project delivery.

Further study

Future qualitative research will be conducted to identify and explore the various drivers of satisfaction within each of the five maxims of project satisfaction. Once these drivers of satisfaction are identified, quantitative research will be conducted to measure the impact of each driver on overall satisfaction.

Focus groups were ruled out to conduct the qualitative research because IT decision makers might be hesitant to reveal potentially embarrassing information in a group setting. Thus, this information will be gathered on a one-to-one basis. Both mail and web-based methodologies are being considered to conduct the quantitative research.

This information will then be used to begin to develop a set of project satisfaction 'best practices' to be used by project managers before, during and after engagements.

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End-users in academia: meeting the information needs of university researchers in an electronic age

Part 2

Innovative information-accessing opportunities and the researcher: user acceptance of IT-based information resources in academia

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This paper is the second part of a two-part paper, which examines the transition to the electronic information era in academia. Seeks to establish from the published literature to what extent university researchers have accepted, and adapted to, the changes wrought in information activity by seemingly endless technological developments Within the wider context of the impact of the changing information environment on each of the three clearly discernible components of academic research (the creation of knowledge and standards, the preservation of information, and the communication of knowledge and information to others), disciplinary-rooted differences in the conduct of research and their influence on information needs are identified, and the resulting inter- and intra-individual variations in researchers' information seeking behaviour are explored. Reviewing a large number of studies investigating the integration of electronic media into academic work, an attempt is made to paint the picture of academics' progressively harnessing the new technologies to scholarly information gathering endeavours, with the expressed hope of affording some insight into the directions and basic trends characterising the information activity of university faculty in an increasingly electronic environment.

Ask any librarian or information scientist and you will be told with unhesitating assurance that the emerging electronic library is God's gift to academics, providing as it does easy and quick access to more and better information. If you ask the academics themselves, the answers may not always be that definitive or enthusiastic, although the literature of the past three decades or so provides ample evidence to their steadily growing appreciation of IT based information resources

The integration of electronic media into academic work has been investigated in a large number of studies, each contributing an additional detail to the slowly emerging picture of university faculty progressively harnessing the new technologies to scholarly information gathering endeavours. However, before we look at the various studies, a word of caution the works cited differ so widely in aims, objectives, definitions and methodologies, that it is difficult to compare their findings.

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Thus, the picture drawn is by necessity somewhat fragmentary and impressionistic in nature.

Integration of technological innovations into the information seeking work of the researcher – the groundbreaking years

By the 1970s the euphoric visions of the previous decades as to the capabilities of computers have given way to more realistic perceptions of the possible uses of technological innovations in the information seeking work of the researcher. IT based sources and services, though at the time still rather time-consuming and labour intensive, undoubtedly began their slow, but sure progress towards widespread availability and adoption for meeting information needs arising in the course of research work.

Raben and Burton (1981, p 248), in their state-of-the-art report on information systems and services in the arts and humanities, note, albeit with surprised wonder, the emerging impact of computers on research even in a field traditionally seen as anti-machine:

> The most significant trend for computer-assisted humanities or social science research in the past few years has been the increase in the number of 'hybrid scholars', those who combine training in traditional academic fields with computer technology, and vice-versa. Some, indeed, hold joint appointments in departments of computer science and departments of humanities and social science Some have degrees in mathematics as well as in music or English. Some alternate their employment as humanities professors with service as computer programmers. Such scholars are sometimes viewed by their colleagues with suspicion and apprehension. The narrowness of academic disciplines, however, has constantly lost out to multidisciplinary orientations; in the recent past biophysics, biochemistry, biosociology, psychiatry, and anthropology were all responses to a need to expand beyond established borders. Likewise, computer-oriented humanities research, which until recently was colored largely by the novelty and massive impact of the computer, has already become almost ordinary in some universities. Even those bastions of academic tradition, language departments, are occasionally including computer terminals and printers in their requests for standard equipment, and most such departments are more than willing to provide computer time for interested faculty members ..

Stone (1982), too, comes to the conclusion that 'scholars are viewed as resistant to computer technology yet are using it in many fields on an expanding basis (p. 306)', citing the literature of the time, which, she claims, seems to extol the virtues of the computer for humanities scholarship, in general, and for computerised information retrieval, in particular, with 'something of the missionary fervour in places (p 300)' However, Crawford (1986) describes humanists' perceptions of evolving technologies in much less enthusiastic terms:

> In the course of more modest triumphs we have also seen colleagues suffer through some ambitious and expensive failures. As a consequence, many of us have become more cautious over the past twenty years. Before investing time and energy into an evolving technology, we want to be convinced that the investment will be repaid, preferably with interest. Surely a large majority of humanistic professors now use a computer for word processing, and we all know of some whose computer applications are truly impressive. But of those who work with computers, only a few, perhaps 20 per cent, use their machines for anything more than typewriters (pp. 569-570)

Nevertheless, Crawford too is convinced that:

> . .evolving technology holds great promise for helping meet the information needs of humanists.. [provided that] the former logical and simple methods of locating information are replaced by new tools that appear equally logical and simple (p. 574).

Talking about approximately the same period (from the mid-1970s until the end of the decade), but from the angle of the scientist researcher's adoption and utilisation of online bibliographic searching technology, Bayer and Jahoda (1981) also report that computensed access to information is becoming more widespread, with an increase of 75% in the number of databases, a tripling of the number of records, and a quadrupling of the number of online searches. However, having found in their empirical study of the effects of online bibliographic searching on scientists' information style, conducted over a year's time, that online searching did not generally diminish the amount of use of other traditional manual means of information gathering activities, they voice the then prevalent view that online searching was not meant to be substituted for the old manual approach, but merely to be added onto previous methods

Across the Atlantic the situation on the eve of the 1980s seems to have been much the same. In a study of the scientific information system of the United Kingdom, conducted from 1978 to 1981 by the Committee on Scientific Information of The Royal Society, scientists were asked if they had ever performed an online information search or had one done for them by someone else Fewer than half of the respondents reported that they had used online retrieval systems (223 said yes and 365 said no), and it was university respondents on the whole who had not used them Of those who had used online systems, 156 were satisfied with the results and 182 would use them again, and of those who had not used them, 244 would like to and 96 would not. The major reasons given for non-use were: 'do not know how' (106 respondents), 'no terminal available' (80 respondents) and 'lack of funds' (63 respondents). The findings did not reflect a very eager reception of the novel methods of information retrieval. However, the author's conclusion, based on the willingness expressed by the substantial majority of the respondents to use online information systems, and by about a quarter of the respondents even to switch to electronic journals, is that a liking for computer-based methods of information retrieval can be clearly seen and growth in the use of online information systems is clearly wanted (Rowland, 1982) True, by now information professionals have learned to grow more wary of taking declarations of intentions too seriously, realising that the use of innovative information technologies has joined motherhood and apple pie in the 'politically correct list' of many people.

Academic information activity in a progressively electronic environment: increasing awareness of technologies' potential contribution to research work

After the foundation-laying years of the seventies, the next two decades leading up to the present saw the electronic revolution taking place in two phases. In the first, the essential raw materials of research – books, periodicals and other publications – were still in traditional print-on-paper forms, but their electronic records enabled researchers to avail themselves of enhanced information retrieval and access opportunities In the second phase, with the raw materials themselves becoming ever more available in electronic form and the burgeoning development of networking, the information itself became accessible directly from the researcher's desk Since the 1970s the card catalogue has gradually given way to the online catalogue, which in its turn has expanded from a single-library finding tool into a gateway to a universe of information resources in printed and electronic forms (the holdings of other libraries, databases of millions of journal articles and the vast range of information accessible via the Internet). From the 1980s onward electronic databases, representing indexing and abstracting services as well as encyclopaedias, directories, and other reference tools, have been made readily available to potential users in one of three ways:

- as CD-ROM (with the possibility of networked CD-ROM access),
- locally mounted, that is, loaded onto the university's own computer network;
- at a remote location, to be accessed as the need arises

The 1990s greatly enhanced researchers' information handling capabilities, offering them a constantly growing array of Internet-based full text databases and electronic journals, with hypertext and hypermedia linking, marking the way to the evolution of the digital library and the goal of providing flexible, demand-based electronic access to information that often has no physical format or location (Lancaster and Sandore, 1997). Concurrent with these far-fetching developments in the information environment, a continual, though unhurried movement toward the integration of the new information tools and sources in academic research work has been taking place.

A nation-wide survey of online catalogue use in the United States revealed that in 1982 only about 7% of all online catalogue users in academic libraries were faculty members (with the meagre 7% even including staff). Prompting the investigators to conclude that faculty and staff may represent a group of users among whom there is greater resistance to the use of the online catalogue (Matthews, Lawrence and Ferguson, 1983). However, findings of a faculty study, conducted at the University of Houston – University Park, as little as three years later, are definitely indicative of greater acceptance of the online catalogue As much as 90 3% of the total number of 196 respondents considered themselves users of the online catalogue (although 38% professed to use it only occasionally or rarely), despite the fact that it did not contain the complete holdings of the library's collection, and that for all practical purposes was accessible only at the library itself Dial-in access, via personal computers, was made available shortly before the questionnaires were mailed out, but had not yet been publicised (Frost, 1987).

Adoption of other electronic information services, although lagging a year or two behind the acceptance of the online catalogue, nevertheless followed the same pattern of steady increase.

A survey, conducted in the first half of the 1980s (the authors do not specify the dates but it clearly refers to the period just before publication in 1985) among academics in the United States and Canada in the fields of biology, chemistry, physics, psychology, economics and sociology still paints a less than glowing picture of the use of IT based resources. The very low response rate of 19% (44 out of 237) in itself testified to a lack of interest and lack of understanding of computerised databases and their potential for scholarship. Indeed, the findings proved any such suspicion to be only too realistic. even the 44 interested faculty members, who did respond, made little use of databases, tended to know little about them, and usually did not see the need to learn more (Borgman, Case, and Ingebretsen, 1985).

However, another questionnaire survey undertaken shortly afterwards, in 1985-1986, in order to characterise the extent of computerisation within UK academic departments, already shows signs of a more receptive attitude towards IT based information services. The mere fact that it has fared better in eliciting responses (of 108 science, social science and arts departments canvassed 75 (69.4%) returned questionnaires). In all, 499 out of 973 questionnaires were returned in time, representing an overall response rate of 51.3%, which can in itself be seen as an indication of a more positive attitude towards the new technologies. Indeed, the findings themselves suggest that computers definitely entered academic information work and were used for all of the core research activities, if as yet only to a limited extent: 24% of the respondents reported having used computers for searching online databases, 31% for data collection, 48% for data analysis and 50% for data display. Having compared his findings with others obtained in a previous survey, the investigator guesstimated that the figures of his survey were an overestimate of the situation by approximately one quarter, and should in fact be 18% for searching online databases, 23% for data collection, 36% for data analysis and 38% for data display (Heeks, 1987).

The results of another survey, conducted at approximately the same time (1985/86) at the University of Manitoba, Canada, by Horner and Thirlwall (1988), also imply that by the mid-eighties the 'Online Era' did have an impact, however modest, on researchers' information gathering habits. Information retrieval technology was found to be of interest to researchers, and was being used by them, although to no great degree. Out of 766 respondents, 54 (7.1%) had had database searches done for them many times, 214 (27.9%) occasionally, 168 (21.9%) rarely, but 330 (43.1%) had never used the service. The number of end-users was even smaller: out of 762 respondents, 48 (6.3%) had many times conducted searches personally, 99 (13%) occasionally, 103 (13.5%) rarely, but 512 (67.2%) had never done so. Moreover, 236 researchers (42.9%) perceived a lack of pertinent databases, although when asked to indicate the printed indexes used, most turned out to be searchable in a computer-readable format as well. What is more, the authors were of the opinion that the reported attitudes towards, the interest in and the easy access to database searching demonstrated a potential for increased use (Horner and Thirwall, 1988).

Findings of a 1987 study among a random sample of 119 faculty and graduate students from four social science disciplines (industrial relations, anthropology, sociology and economics), conducted at the University of Wisconsin-Madison, again point to academics' increasing awareness of the novel technologies' potential contribution to their work, even if that awareness was at the time still waiting to be put to practice. Although the researchers ranked the only three services out of seventeen which involved electronic technologies (searching the online library catalogue, conducting an online database search with a librarian and performing their own online search) as the least preferred sources of information, the investigators concluded from respondents' comments on the questionnaires that they did recognise the importance of computerised information services in the research process, even if they had not yet familiarised themselves with the new resources (Folster, 1989).

Joining the ranks of electronic scholars: the diversity in user behaviour among researchers

Having thus seen the steady (if slow) progress made until the end of the eighties towards the uptake of electronic information accessing methodologies in research work, it is important to note that the disciplinary-rooted differences among researchers cropped up immediately as the move to the electronic information environment started in earnest, with humanities researchers seeming to be less inclined to join the ranks of electronic scholars than their colleagues in the social sciences. One possible explanation given in the literature is that in the humanities computer-based resources did not bring about the same shift in perspective that occurred in the sciences and the social sciences, with their computer-based use of quantitative information. In consequence, in the humanities the scholarly tenure and promotion systems did not encourage the creation of databases, the development of software to manipulate them, or the publication of scholarly research based on electronic texts. As a result, the market for such products was too weak to support the kind of commercial investment required to produce scholarly tools. Also, probably for the same reason, in the humanities, more than in the sciences and the social sciences, research based on electronic resources did not carry the prestige of a traditional piece of scholarship. It was mostly published in marginal journals and, as a consequence, counted less when tenure review time approached (Shreeves, 1992). The literature puts forward a host of other explanations, all probing more deeply into the psychological and philosophical reservations which may be at the roots of humanists' tendency to view computers and computer-aided research differently than their counterparts in the sciences or social sciences. Such as (Saule, 1992):

- possible negative experiences in childhood and adolescence with machines;
- the fear that, because the computers can do so many things that we cannot, they will become the psychological prototype for the new man or woman;
- dislike of the computer and information technology jargon, seen as abuse of the language which is so dear to the hearts of scholars in the humanities;
- the possibility that computer-based research will eliminate the nuance and judgement inherent in humanistic research,
- the concern with computers signalling the end of the book or endangering the centrality of browsing and serendipitous information retrieval,
- and, perhaps the greatest fear of all, that computers would render the humanities (and humanists) irrelevant.

Although the attitudes, fears and concerns ascribed to humanists seem to become less and less pervasive with time, they certainly did characterise the first years of the transition to the electronic environment. Thus, Stern's (1988, p 161) more than a decade old claim, that:

> Scholars in the humanities, dependent as they are upon the written word in the form of books, journal articles, and primary source materials secreted in dusty archives, have until recently been reluctant to explore the possibilities and opportunities presented by the emerging technologies represented by computers, electronic data retrieval networks, and machine-readable resource materials.

is amply borne out by the empirical findings of studies conducted throughout the 1980s.

Hurych (1986), in her study based on 462 university faculty search request forms for online services, collected 1979-1984, found that the least frequent faculty users of online services were humanities researchers. They accounted for 44 requests (9.5% out of the total number of requests), as opposed to 255 requests (55.2%) from the social scientists, although scientists seemed to manifest not much more enthusiasm than the humanists, with their 53 requests (11.5%). However, considering that there were almost twice as many faculty members in the social science disciplines in the university, and also that they had been more exposed to online searching opportunities, these results cannot be taken for anything other than weak evidence that humanities researchers make little use of electronic information services Thus, for example, Heeks (1987) showed that on average scientists were using a computer for more activities than social scientists who, in turn, were using a computer for more activities than arts researchers. Online searching was more widespread among scientists than among arts researchers (who, however, were found in this survey to be heavier users of these services than social scientists!): 28% of scientists used a computer for searching online databases, as opposed to 22% of academics in the arts and 15% of the social scientists.

Horner and Thirwall's (1988) findings also pointed in the same direction. According to their study of mediated and end-user database searching practices, humanities researchers used the database search service of the library much less (1.9% many times, 9.4% occasionally and 14% rarely), than either social science researchers (8.8% many times, 29.9% occasionally and 22.4% rarely) or science and technology researchers (7% many times, 31.9% occasionally and 24 3% rarely). Also 75.5% of humanities researchers, as opposed to 36.8% of science and technology researchers and 39% social sciences researchers, had never had a database search done for them. (Surprisingly, although humanities researchers were the least enthusiastic about librarian-mediated use of computerised databases their percentage among the end-users was similar to that of the other groups. The authors suggest that this might have been due to the fact that at the time only those few individuals who were comfortable with or had a special interest in the technology tended to conduct their researches personally.) Lougee, Sandler and Parker (1990), in their 1983-1985 study of attitudes and behaviour regarding both remote storage and technology among 212 humanities faculty and 254 graduate students, also reported that the resources they used most frequently for bibliographic information were the card catalogue and citations in books and articles; the least used were computerised databases and librarians. Moreover, training in the use of online technology and the provision of department-located terminals brought about little change in attitudes and patterns of use.

The accelerated move to the electronic information environment in academia: giving way to novel methods of meeting research information needs

There can be little doubt then, that humanities researchers were indeed somewhat more extreme in their reluctance to embrace the new technologies, but it must be remembered that academics as a rule seemed to prefer proceeding cautiously, not to say hesitantly, towards acceptance and use of IT based resources for meeting their information needs Thus, it is hardly surprising to find Mackenzie Owen and Halm describing the situation in 1989 as follows·

> Printed documents still are the prime instrument for formal scientific communication .. [although] the integration of new media (magnetic and optical storage techniques), computer technology (especially micro-processors and personal computers) and telecommunications (data networks, satellite links) results in new products and services which, in many cases, are capable of replacing the printed document This is not to say that these new products shall replace the printed document. Possibilities do not always become reality... In general, users of scientific and technical information seem to show resistance towards learning new methods for acquiring and handling information.. So one has to be fairly pessimistic about the chances of technological innovation of information transfer being accepted by end-users. This problem is probably not really specific for the users (authors and readers) of scientific and technical information. ..In our view, there is little market demand from the part of the information users with respect to the introduction of new technology, let alone with respect to structural change of the entire system of producing and acquiring information (Mackenzie Owen and Halm, 1989, pp 22-23).

Looking back in 2001 on the past twelve years that have elapsed since Mackenzie Owen and Halm wrote these words proves them to have been overly gloomy the scientific and scholarly users did make further significant strides towards the acceptance and consequent utilisation of new information products. In fact, the adoption of IT based resources and services, however gradual, has probably been more inevitable for the academic researcher population than for most others, dependent as they are on information. Just what is the nature of the causal relationship existing between the needs of academics and developments in the information scene is a question that may not be fully resolved yet Or as Henderson and MacEwan (1997) put it, 'like the chicken and the egg, the electronic collection and the wired faculty enjoy a which-came-first relationship (p 497)'. In other words, it is not entirely clear whether electronic information resources create wired faculty or whether faculty needs and requirements drive the developments in academic information services. Empirical findings seem to point more towards the changes in the information environment exerting an influence over faculty attitudes and behaviour than vice versa. For example, in theTAPin (Training and Awareness Programme in Networks) experience, the changes occurring in the IT culture among academic staff in education, law, and life sciences in six UK universities in the course of 1995-1997 were traced back to changes in the information environment. This included the growth in desktop access to the Internet, the significant increase in the use of e-mail and the Web, and the planned, targeted support in using networked resources provided in the project (Reid et al., 1998). Be that as it may, what can be said in all certainty is that there is a natural relevance between information and university teaching and research, which ensures that academics will always be central players in the information arena Indeed, reviewing the literature of the 1990s and 2000s clearly shows that the integration of the novel methods for gaining access to information into academic research work has been continuing unabatedly.

By 1992, findings of a survey conducted at the State University of New York and focusing on faculty needs, attitudes and expectations related to electronic technologies and information services, were interpreted as being indicative of an overall receptivity to electronic information resources and of a growing level of both readiness (in terms of equipment) and actual use. Although the 27% response rate – 1,007 respondents out of 3,713 faculty, selected administrators and professional personnel – probably suggests that the overall picture may be somewhat less optimistic, considering that those who elected not to participate in the survey were more likely to be non-users of the electronic resources. Still, the availability of personal computers among the respondents appeared to be nearly universal. More than 95% reported that they had a computer in either their home or office, though a significantly lower percentage of respondents had their office computers connected to the campus network (66.5%), even less had communications capability from their office (55.4%) or home (53.4%), and only 29.6% had their home computer connected to the campus network. As to faculty use of electronic information resources, the findings clearly indicate that the trends identified in previous studies continued. The information resource used by the largest percentage of faculty respondents was the campus library online catalogue, with 12.4% of the respondents using it daily, 38.6% weekly, 25.3% monthly, 14.2% infrequently and only 7.7% reporting never to have used it. Another information resource in use were index/abstract databases loaded on the campus online catalogue: despite quite limited offerings at the time of the survey, 2.9% of the respondents used them daily, 15.1% weekly and 20.6% monthly. However, 29.3% professed to have used them only infrequently and 29.4% had never used them at all. CD-ROM index/abstract databases, available at specific stations in the library, seem to have been even less popular, with 21.4% of the respondents reporting infrequent use, and 46.6% saying they had never used the source at all. Reported use of electronic journals and full-text-databases was still lower: 68% of the respondents had never used the former and more than 80% – the latter (Adams and Bonk, 1995).

Comparable usage patterns were found in two additional surveys conducted at the beginning of the 1990s The first carried out in 1993 at Eastern Illinois University in order to determine the level of awareness, usage and general impressions of electronic resources available in or via the library (Laribee and Lorber, 1994). The second conducted in 1994 at Western Michigan University (WMU), to explore the relationship between faculty use of university libraries and faculty use of computers (Vander Meer et al., 1997). As in the SUNY survey, in both these surveys the low response rate (of about a third, 250 out of 785, at the Eastern Illinois University and 42.3%, 314 out of 742, at WMU) has to be kept in mind, as a possible indication of bias in the results. As to the findings themselves, both surveys lend support to the State University of New York (SUNY) finding, according to which the information resource used by the largest percentage of the respondents was the campus library online catalogue. Although with 66% of the respondents reporting its use at Eastern Illinois University and 61% at WMU, it seems a far cry from the more than 90% use reported in the SUNY survey. The investigators of the WMU study, who were aware of the SUNY survey, explained this almost 30% difference by the limited number of faculty members having access to network connections in their campus offices at the time that the survey was done. Also, all three surveys found that CD-ROM databases were used by about half of the respondents. However, while at Eastern Illinois University even the most popular among the various online index/abstract databases available was used only by around one-third of the respondents (with use of others ranging from 10.8% to 25.2%), more than 70% and 62.9% total usage of online services were reported in the SUNY survey and the WMU survey, respectively.

A University of Illinois study, focusing on the social sciences, as represented by 148 faculty members (in disciplines whose literature is covered by ERIC, education, psychology, social work, kinesiology, and women's studies), came up in 1992 with results pointing toward the growing interest in the new information technologies and services in this specific group. Of the 79 respondents, 44 (55.7%) indicated that they had campus computer accounts for the internal Academic Data Network, 75 (50.7%) respondents had access to the campus network from their offices and 65 (32.3%) from home, although between 7% and 21% professed not to know if they had access to the network either in the campus or at home. Of the 81 respondents 24 (29.6%) reported to have used the readily-available (searchable on terminals in all library sites, on networked campus computers, or by remote access using office or home personal computers), no-cost, online ERIC resources, with use of less easily accessible databases seeming to be not much lower. For example, Psychological Abstracts, which had been made available only shortly before the survey on CD-ROM at single workstations in one departmental library, was used by 12 faculty end-users out of 66 (18 2%). Twelve additional faculty reported searching the database from their own computers and 9 (13 6%) having had searches performed for them by librarians. Moreover, 34 faculty (41.9%) indicated that they used other libraries to search indexes or online databases (Fiscella and Proctor, 1995).

Again looking at a specific disciplinary group, this time of scientists, findings of two separate studies into their acceptance and use of electronic information resources, conducted a year later, in 1993, indicated that members of this disciplinary group too, manifested a growing appreciation of the innovative technologies. One survey, undertaken in order to examine the factors influencing the adoption and use of electronic networks by science and engineering faculty in six small universities in the south-eastern US, gathered data on the purpose, type and extent of their use of electronic communications and information services Out of the 371 faculty who had been sent questionnaires 216 (59%) responded Therefore, as the authors suggest, the findings should be interpreted carefully given that the 41% who did not respond were more likely to be non-users than users of the network. However, the majority (65%) of those who did respond used the electronic network, with 39% reporting the use of one or two network services, 61% three or more and 52% reporting use of some network service at least once a day. In terms of services used, e-mail was predominant, with 97.9% of the respondents reporting its use. Surprisingly, the respondents did not consider electronic discussion groups a major resource, although such a resource could be a benefit for small and relatively isolated institutions File transfer and interactive access to remote databases were also fairly well used (by 65.2% of the respondents), most often to support teaching and research, since access to Internet resources was perceived as 'levelling the information playing field' Moreover, almost all respondents interviewed for the study expressed the view that an Internet connection was indispensable to at least some aspects of academic work (Liebscher et al., 1997) The other survey of scientists' use of electronic information resources, conducted at The University of Alabama, Tuscaloosa, had been sent to 280 science and engineering faculty Here again, the disappointingly low response rate (only 35%, 83 faculty members, returned the questionnaires) led the investigators to speculate on possible apathy among researchers as to electronic resources. However, among the faculty who did respond (probably because they held more positive attitudes as to the novel information tools) 96% saw personal computers as one of the necessities of their work environment, and even the remaining 4%, who had not used them, believed they might still do so Online databases and CD-ROM databases were used by 49% and 42% of the faculty respectively, with 42% even choosing database/CD-ROM/electronic networks as the most frequently used resource for locating information (even if the majority did prefer to perform the searches through intermediaries, be it librarians or research assistants). This was in spite of more than half of the respondents expressing negative opinions about the electronic information products in terms of their comprehensiveness, ability to provide relevant information and ease of use. Furthermore, electronic databases featured high on respondents' lists of services that the library should spend more money on, higher than buying books and not much lower than purchasing journals (Mehta and Young, 1995).

In a survey conducted three years later, in 1996, the scientific community's move to electronic information technologies seems to have progressed significantly The survey, conducted within the framework of the SuperJournal project, gathered data from 70 scientific users in 4 UK universities on a variety of topics related to the project, including their use of electronic services. Most of them (94%) used the Internet weekly or more frequently, 80% used online bibliographic services weekly or more frequently and 54% used electronic journals weekly or more frequently (Pullinger, 1999). The changing pattern of e-services use among scientists was yet again demonstrated in another 1996 survey, this time among Canadian chemists. Although in this case the 37% response rate (131 out of 355 questionnaires sent) may be a sign of a less than all-embracing enthusiasm towards the electronic resources. The chemists who did respond were well provided for in terms of equipment and connectivity and testified to considerable need for and use of the IT based services: 99% had computers, 89% had access to communications software, 87% connected to the campus network, 64% had access to CD-ROM equipped computers and some 40% used the campus online catalogue at least weekly. Databases and indexes available on the campus network or catalogue were used by 60%, while only 25% regularly used databases on CD-ROM in the library Index and abstract databases from commercial systems were used by 43%, with 77% indicating they had database literature searches done at varying frequencies during a year. A considerable number of chemists considered their knowledge of how to use the Internet and World Wide Web moderate to good, 41% and 37% respectively. Moreover, only 15 of the 131 chemists reported that they had no interest or need to use electronic information technologies. Although quite a few complained of one or more obstacles to use, the major impediment proved to be lack of time to explore the new technologies, noted by 73%, along with lack of information on available databases and lack of training in how to access electronic resources, remarked upon by 24% and 35%, respectively (Noble and Coughlin, 1997).

The UK picture of researchers' attitude to the new electronic information services, painted in great detail in 1995 as part of a British Library Research and Innovation Centre (BLRIC) commissioned survey among 2,330 academics, also clearly points to the increasing importance accorded by that time to IT based resources in academia. The survey, undertaken in order to examine both the importance of university libraries for academic research and the availability and use of information technology and electronic services by academics, was closely modelled on an earlier study carried out six years before, with the explicit aim of looking into the changes that had taken place since then. The results undoubtedly showed that access to and use of information technology was becoming increasingly widespread among academics: 75% of the respondents said they had access to at least some network services through their university library, and 68% had direct access through their own PC. However, out of seven network services only two were accessible to the majority of the respondents through their university library, bibliographic databases (63%) and e-mail (51%), with four additional services available to one in five respondents only: ordering books and journals (26%), bulletin boards (25%), electronic publications (25%) and full-text services (20%). Expert discussion groups were the least accessible, mentioned by only 15%. In general, four in five respondents (81%) thought that access to information had become easier and more convenient because of automation, networks, electronic databases, etc., and about half (46%) believed that research had improved as a result of having easier access to external databases. Some electronic services were perceived to be more important than others: of seven network services, only two, e-mail and bibliographic databases, were described as important for research purposes by a clear majority of academics, over seven in ten respondents. Ordering books and journals came third on the list, with 47% saying it was important Electronic publications were important for two-fifths of the sample (39%), expert discussion groups for one-third (34%) and full-text services for just under one-third (30%). Least important were bulletin boards, mentioned by 24% – one in four respondents. About two in five respondents said it was important for their research to have good access to online external databases two in five academics considered this very (16%) or fairly (25%) important, while three in five said it was not very (36%) or not at all (23%) important. In fact, only one in four academics professed never to have used the service, either at their university library or through their own PC. A finding of special importance for this review of the increasing acceptance of IT based resources in academia concerns the views held by the 1995 survey participants as to the effect of the developments on their research since the previous survey of 1989.

53% of the respondents reported that they used electronic collections more, 33% perceived no change, and only 1% reported less use, 39% reported having made more use of (librarian mediated) database searches, with another 39% feeling no change and 6% noting a decrease in use; and finally, 35% believed they browsed online catalogues more, 3% less and 42% felt no change (Erens, 1996).

Another 1995 survey, this time seeking to afford some insight into the thinking and practice of US university faculty regarding the incorporation of networked information into their research work, was conducted at eight universities, representative of both private and public governance structures and dispersed geographically across the country. Also, the population was chosen so as to be representative of the three major academic areas. sciences, social sciences and humanities Again, the return rate was too low to draw any absolute conclusions, but the findings clearly showed that researchers employed networked information into their work in a variety of ways. The mere fact that most of the respondents had Internet access at work is in itself indicative of the progress made in no more than a few years Of the 647 respondents, 91.6% reported network accessibility, as compared, for example, to the significantly lower percentage of respondents saying they had such accessibility in the 1992 State University of New York survey, where only 66 5% had their office computers connected to the campus network and 55.4% had communications capability from their office (Adams and Bonk, 1995). Moreover, the respondents reported quite intensive use of networks Nearly 87% of the respondents accessed the Internet for communication activities, such as e-mail or listservs more than once a week, with 52.8% doing so more than once a day While use of networked resources for information seeking was less widespread, with 275 out of 632 respondents (43.4%) conducting network searches for data or texts, 360 out of 644 respondents (55.3%) reporting searches in bibliographic databases and 385 out of 645 respondents (59.7%) in catalogues of other libraries, the absolute numbers of users were still substantial Indicating that such information seeking practices were not uncommon (Budd and Connaway, 1997).

Yet another 1995 survey, conducted in a very small corner of the world, albeit in a major research university in a developed country, focused on exploring differences in usage, training and perceived importance of the Internet among faculty at the Hebrew University of Jerusalem in Israel Here too, academics were found to manifest readiness for and appreciation of electronic services· among the 462 respondents, only 39 (8.4%) stated that they did not use computers at all and 371 (80 3%) said they were users of the Internet E-mail was reported to be by far the most popular Internet service, used by 362 of the 371 users. But there was also substantial use of other services· 45% (of the 188 who answered the question) reported participation in discussion groups, with 21% ranking it indispensable, 48% of the 197 who responded to the query on file transfer capabilities of the Internet used them, this time with 56% finding it indispensable, and 35% of the 175 informants on searching for information over the Internet made use of this service, with 39% ranking it indispensable Moreover, an overwhelming 83% of the 310 respondents to the question on the specific ways in which Internet use had influenced their research or teaching said that the Internet had increased their co-operation with colleagues, and nearly half considered the provision of fast access to databases (46%) and fast research updates (43%) ways in which the Internet had changed their professional lives (Lazinger et al , 1997)

These findings are lent support by the results of two additional 1995 surveys, carried out halfway across the globe in Australia One survey (Applebee et al., 1997) set out to identify the frequency and type of use that academic staff were making of the Internet in the University of Canberra. In this study too, the principal use of the network was for e-mail, but approximately half of the informants also used their Internet access to participate in online discussion groups (about the same percentage was reported in the previously cited Hebrew University of Jerusalem study). Accessing databases was found to be quite popular as well, with 52% of the 243 respondents reporting the use of Telnet and 47% that of a WWW browser for the purpose. These findings are roughly similar to the 55.3% of respondents performing networked database searches found in the above-cited 1995 US survey (Budd and Connaway, 1997), but somewhat higher than the 35% who reported searching for information over the Internet in the Hebrew University of Jerusalem study. The other survey (Bruce, 1998), focusing mainly on how satisfied Australian academic end-users were when they used the Internet to search for information, also collected data on the extent of their use of the network for the purpose. The findings, obtained by interviewing a randomly selected sample of 37 academics from 5 universities, admittedly representative of the whole population only to a limited extent, are still revealing, pointing as they do to the general directions discerned in the two previously cited studies on the subject of information seeking over the Internet. Although the majority regarded themselves as infrequent users when it came to information seeking, 41% indicated that they used the Internet for the purpose at least once per month and large proportions (30% and 24% respectively) used the Internet this way once per week or even every day. Moreover, there were no academics in the sample who claimed to use the Internet for information retrieval only once per year and no more than 5% of the sample reported such use only once per six months.

Another study focusing on university faculty's use of the Internet in its country of origin, the United States, was conducted in 1996. The study was carried out among the entire faculty body in a public university. 158 faculty members, out of the total sample population of 180, took part in the survey (a response rate of 88%). The findings of this survey undoubtedly augment previous research, with its data closely tallying with that of the above cited studies and clearly pointing to faculty awareness of the support provided by the Internet for teaching and research. The Internet was used by 85% of the respondents, an almost identical figure to the 80.3% found in the Hebrew University survey. Here too e-mail use was shown to be almost ubiquitous, with 96% of the respondents reporting its use in order to keep them connected with their professional counterparts worldwide for a variety of academic activities. Faculty use of mailing lists (listservs or discussion groups) was found to be relatively low at 29%, lower than the 50% or so reported in both the Hebrew University and the University of Canberra surveys. Regarding information search and retrieval, the findings of this study, with the World Wide Web showing the highest rate of use (55%), gopher rating the second (48%) and FTP the lowest (22%), again resemble quite closely the Australian surveys cited above, although not that of the Israeli survey, which found somewhat lower use (Wang and Cohen, 1998).

By 1998, a study of faculty reaction to the ever-increasing modes of electronic access to information, conducted at the University of Nevada, Las Vegas (UNLV), found extensive readiness to adopt the technological innovations, whether supplied by the library or accessible through the Internet. The investigators, intending to carry out a study of an exploratory and qualitative nature, made no attempt to select a statistically representative sample of faculty. Basing their study on the diffusion of innovations theory, they explored the experiences and concerns of selected UNLV faculty who appeared to represent three adopter categories: the innovators/early adopters, the early/late majority and the laggards. Identified in a series of focus group sessions (with a total of 26 participants) and 6 personal interviews with faculty, the key theme in faculty attitudes, perceptions and behaviours in response to technology was the benefiting from the convenience the new digital environment afforded them, with the differences between the adopter categories far fewer than expected, and mostly relating to the presence or lack of 'awe' toward new technology. Although there still seemed to be obstacles that limited the effective use of IT based information systems, such as lack of knowledge about what was available, potential inhibition with the use of the new technologies and local technological difficulties, there appeared to be an overall accommodation with the electronic resources and services (Starkweather and Wallin, 1999).

Findings of another 1998 study (Zhang, 1999), investigating scholarly use of Internet-based electronic resources among library and information science researchers in the US, although possibly not wholly generalisable to other areas, nevertheless afford insights as to the degree of readiness in academia to adopt the variety of electronic information resources, both in terms of the necessary technological infrastructure and the willingness displayed. The majority of the 156 participants in the survey had good access from the workplace to a wide variety of Internet tools and resources: e-mail (94.2%), web browsers (92.3%), mailing lists (90.4%), online databases (82.7%), telnet (83.3%), ftp (80.1%) and newsgroups (69 9%). A sizeable portion of the respondents also had access to these e-resources from home, but generally the access rate was nearly 20% to 30% lower than from work. It is interesting to note in this context, that in a study conducted ten years earlier among some 200 behavioural researchers from the UK, the Netherlands and the USA, aimed at examining how information technology was used at home by researchers, the majority of the informants used computers at work daily and also regularly worked at home About half of them using computers for work at home, but only 20% reported e-mailing from home and nobody even mentioned carrying out online literature searches from home (Wright, 1990)

Also, in the above-cited 1992 SUNY survey, despite the fact that more than 95% of the respondents had a computer in either their home or office, only 53% had communications capability from their home and even less (29.6%) had their home computer connected to the campus network (Adams and Bonk, 1995). As to the research-aiding opportunities offered to the academics via the Internet, the population surveyed seemed to put these to extensive use indeed Consistent with findings of the above quoted studies, e-mail was the most frequently used tool, with all respondents using it at least once a week, and 93.6% using it almost every day. On the other hand, in comparison with earlier data on information seeking over the Internet, this service seems to have gained popularity: nearly 95% of respondents used web browsers at least once a week and, among them, 75% reported use on an almost daily basis, 68 2% used search engines and over half of the respondents used telnet and online databases at least two or three times a week. By this time even participation in mailing lists attracted more academics, with approximately 74% of the respondents using it at least two or three times a week. However, both ftp and gopher seemingly had lost popularity in comparison with previous findings, with only a quarter of the respondents using the former at least two or three times a week, 30% using it even less often and 13.5% not using it at all, and with 81 4% of the respondents using the latter no more than once a month and 48.1% not using it at all. Somewhat surprisingly, despite the heavy use they made of the Internet for their research, over two-thirds (68 2%) of the respondents expressed dissatisfaction with the current state of Internet-based information resources, complaining mostly of a dearth of research sources on the Internet, the instability of e-sources (which made them hard to locate or relocate), the dubious quality of some of the information posted on the Internet, the state of indexing and search engines on the Internet (which tended to cause difficulties in locating e-sources), the need for standardisation and the lack of agreed social norms on using and publishing e-sources

The Internet as a source of academic research information was the subject of yet another study, consisting in fact of two studies conducted approximately twelve months apart (in 1997 and again in 1999), among self-selected end-users in four metropolitan New York academic institutions. Although the investigators included undergraduate and graduate students, as well as faculty, in their multi-disciplinary sample of academic users, their findings as to the frequency of Internet use nevertheless lend some support to the just cited conclusions in Zhang's (1999) article: the vast majority of subjects (91%) reported using the Internet at least once a week, with 46% of them using it at least once a day (Kibirige and DePalo, 2000).

Having thus made what appears to be a considerable measure of progress with the novel tools of accessing information, academic researchers' willingness to accept the new technologies was nevertheless sorely put to test by the introduction of electronic versions of scholarly research journals Launched in the late 1970s and early 1980s, the first refereed journals were heralded as the solution for two major problems of the scholarly communications system. These were the long delays in the publication of research findings and the rising costs of journal subscriptions, which were beginning to hinder libraries, not to speak of individuals, from acquiring all, or even most of the relevant literature. Although the early electronic journals did meet these objectives, they still failed. This was attributable to a variety of reasons, whose common denominator was lack of readiness in academia: the technical shortcomings of hardware, software and networks, the superior portability of paper over electronic formats, the restricted availability of the necessary technological infrastructure, the lack of impetus to change either the long-established conventions of scholarly culture or the deep-seated work habits of researchers, all contributed to user rejection of e-journals (Bradley, 1998; McKnight, 1997; Peek and Pomerantz, 1998; Rowland, Bell, and Falconer, 1997). However, by the mid-1990s the increased availability of computers and the growing network accessibility in academia, along with the changes that by then had taken place in academics' attitude towards the potential advantages of IT based resources and services, and the ensuing adaptations in their working patterns, seemed to have paved the way for the more widespread introduction of the electronic journal. Nevertheless, and despite the many obvious rewards awaiting the researcher, both as author and as reader of scientific papers in the electronic journal, such as immediacy of publishing, easy accessibility, sophisticated searching and browsing capabilities and hypertext linking, McKnight (1997) summed up the prevalent situation in the second half of the 1990s, saying that in general electronic journals still did not support the tasks which users performed, tended to be negatively perceived and consequently were in little demand. Blaming the difficulties on the publishers, who, 'in the journals field at least, don't really care about readers' (p 26), he enumerates a list of problems encountered by the user, including the need to read from screens, usually disliked by users, the less convenient methods for annotating electronic articles, the issue of portability (researchers do not typically read journals at their desks), the difficulties in browsing electronic periodicals, and the frustration of having to adjust to frequent technological changes. Rowland et al. (1997), who also point out that users', and especially university users', acceptance of electronic journals was limited by the general disregard of the human factor on the part of publishers, highlight another aspect of the problem, that of the cost of electronic journals, saying that these were still beyond the means of the users or libraries to buy. Moreover, although the scholarly authors' standpoint as to publishing their research in electronic journals is outside the scope of this review, it cannot be dismissed altogether because of its indubitable impact on the acceptance issue. The picture is described clearly enough by McKnight, who uses a single, but all-revealing word – reluctant – to characterise the general attitude of academic researchers to publication in electronic journals. Budd (1997), on the basis of his survey results, which indicated that only 3% of the respondents had published in electronic journals, comes to the same conclusion, saying (p. 850) that there is 'a lack of trust in electronic journals (or at least a lack of confidence that electronic journals allow authors to reach their intended audience and junior faculty to earn tenure)' Zhang (1999) also finds that the overwhelming majority (94 2%) of the 156 library and information science researchers participating in her above-cited study published only in print journals, and 71% did not even cite e-journals in their papers in the sample (though they might have cited e-sources elsewhere) However, Peek and Pomerantz (1998) cite surveys that indicate that towards the end of the 1990s there may have been some very cautious support to the idea of electronic scholarly publishing. For example, in a survey of Germanists in Canada, believed to be very conservative and traditional, only 36% of respondents subscribed or used electronic journals, yet 58% indicated they would be willing to submit an article to an electronic journal Budd (1997) also found that 53.9% of the 516 respondents who had never published in electronic journals said they would consider doing so in the future, and of those 45 respondents who had submitted articles to electronic journals, about half said they were prepared to do so again.

In light of the subdued reception accorded to the electronic journal, it is hardly surprising to find that by the mid-1990s the number of genuinely scholarly electronic periodicals was rather limited, compared with the total number of printed scholarly journals, and the average size of these periodicals (articles published per annum) was small. Although from 1995 onward most major publishers of established printed scholarly journals made their titles available in parallel electronic and printed forms, offering users hundreds of journals, including many that are core journals of their respective scholarly disciplines, in electronic form (Rowland et al , 1997), empirical studies into scholarly use of electronic information resources repeatedly rank e-journals among the least used sources of information. A case in point is a large-scale survey of library use conducted at Washington State University in 1996, in which, although 39.2% of the 1,033 faculty respondents rated research journals as most important to their work, and the majority (616 or 71%) gave a high priority rating to improvement of the journal collection, over 70% professed never to have used online full text journals (Bancroft et al., 1998). Results of another 1996 survey, exploring perceptions of electronic journals among faculty in science departments as well as library and information study departments of British universities, are in the same vein, despite the especially strong impact of the new technologies in these two subject areas, because of the importance of the fast dissemination of research and the need for keeping up in the one, and the natural relevance of IT to the other. Although the very low response rate (213 out of 1,480 science faculty and 53 out of 250 library and information study faculty returned the questionnaires) is indicative of a possible bias in favour of the experienced users of electronic journals, the general picture is nevertheless one of markedly low use: 54% of all respondents reported that they had never or only rarely used electronic journals, and an additional 30% used them once a year to once a month (Gomes and Meadows, 1999) However, as the end of the 1990s was drawing nearer, electronic journals seemed to be gaining favour, as demonstrated in a cross-disciplinary survey carried out in 1999 among researchers affiliated with the Max Planck Society. Data from publisher-provided usage and transaction statistics gave evidence to a significantly high acceptance of electronic journals among the 811 permanent researchers (out of 3,842) who responded: 86 78% were active users of electronic journals, with the frequency of use reported by the greatest percentage of users oscillating between every two weeks to once a month. Moreover, although researchers still expressed some measure of distrust in the new medium, they considered e-journals important for research and publication of research results and wanted the offering of electronic journals not only continued, but also increased in the future (Rusch-Feja and Siebeky, 1999).

Another study conducted near the end of the decade, in this case among UK scientists, although also indicative of rising levels of e-journal readership (with 60% of the respondents accessing regularly at least one e-journal and 16% more than five), found that the vast majority (95%) of the informants still regularly used print journals, and only half of the 5% who did not, moved entirely to the electronic format (Pedersen, and Stockdale, 1999). This disinclination to give up the print journal seems to be, paradoxically enough, not despite, but because of the emphatically central role of journal literature in the research process Since researchers need to make sure both that they read most high-quality material published in their field, and that they contribute to journals that are well regarded in their research community, they cannot afford to move over to electronic publications while these are held in such low regard. Findings of the above cited survey of British scientists' and information scientists' impressions of print and electronic journals (Gomes and Meadows, 1999) clearly demonstrate the point. The majority of the informants stated that print journals were more likely to meet their expectations than electronic journals, both as to the prestige of the journal (82.5%, as compared to 0.8%) and as to the quality of articles published in it (64.3%, as compared to 0 4%) Thus, a magic circle is formed, slowing down the successful changeover to electronic journals, although the parallel publication of print and electronic forms of journals opens up the way forward Coupled with the potential technological and economic benefits of e-journals, provided, of course, that these benefits come to be fully (or at least to a significant measure) realised, the outlook for the ultimate rise to dominance of the electronic journal can be more optimistic

Researchers joining the ranks of electronic scholars, revisited: still diversity in user behaviour

It seems then that on the whole academics decades-long grappling with the novel electronic information resources is at long last well on its way to widespread acceptance. Moreover, with time the proportion of academics knowledgeable in the mysteries of IT based resources and services is likely to increase significantly, with the younger generation, who have used computers almost since birth, slowly taking over. In fact, even though for the time being many faculty continue to do at least some of their information gathering in traditional ways, several studies point to a greater use of IT based services and sources among younger faculty in the beginning ranks (note, for example, Laribee and Lorber, 1994; Fiscella and Proctor, 1995; Applebee et al , 1997; Lazinger et al., 1997, Vander Meer et al., 1997; Tomney and Burton, 1998; Maughan, 1999; Milne, 1999; Zhang, 1999).

However optimistic the outlook for the uptake of the novel methods of information seeking in academia may be, in the humanities the traditional methods still seem to give way to the new, enhanced technologies at a slower pace than in the sciences or the social sciences. Thus, the discipline-associated differences among academics in adoption and use of IT based sources and services, identified in the literature of the 1970s and 1980s, persisted throughout the 1990s and into the new millennium

Adams and Bonk, in their above cited 1992 State University of New York (SUNY) survey found considerable differences among the disciplines as to the availability of equipment and connectivity: only 55.4% of faculty in the humanities had a PC in their offices, as compared to 84 5% of faculty in the social sciences and over 90% of faculty in the sciences and professional schools who had this equipment in their campus offices. An even greater inequity existed in terms of the availability of connections to the campus networks. In the humanities only 34.3% of faculty had connections to the campus networks, yet in the social sciences 63.3% of the faculty were connected, and in the professional schools and sciences access to the campus network was generally available, with respectively 71.7% and 84% of faculty connected to the network. Building on the findings of a previous study conducted by the Modern Language Association (MLA), the authors suggest that this state of affairs ran contrary to actual needs, as by that time humanities scholarship and teaching presented the same urgency for access to computer technologies and electronic information resources as was necessary in other fields. To be sure, SUNY humanities scholars purchased computer and necessary communications equipment for their homes on a par with faculty in all other disciplines, and pointed at lack of hardware and software as an obstacle to use much more than researchers from any of the other disciplines (Adams and Bonk, 1995).

Another survey, undertaken at the Australian National University (ANU) explored the impact of enhanced electronic access to information in academia by means of two mailed questionnaires, distributed in 1991 and again in 1994. Although giving more interpretations of the empirical findings than hard data, once more the survey seems to underpin the conclusion that the academic culture of their disciplinary areas affects the way academics approach information seeking in an electronic environment However, the patterns of use found seem to have been somewhat surprising, at least as to the use of the online catalogue. It is only to be expected that in 1991, when the catalogue provided access to the ANU library collection only, scholars from the humanities, with their well-documented affinity for books, used it on a daily basis, while social scientists made little use of it, but scientists also reported daily use (of course this may have been nothing but a sign of scientists' relative lack of 'fear' when dealing with computers). More predictably, by 1994, when the online catalogue had become the user interface for accessing remote services, there was an increase in the number of social scientists using it. Also, between 1991 and 1994 there was a strong increase in the number of academics who conducted their own online searches of external databases, with access to online databases from individual workstations deemed important by almost 70% of the respondents. But scientists were more likely to do their own searches than academics from other areas – a finding which seems to support Hurych's (1986) above cited suggestion that the move towards the use of online databases was greater in those disciplines that had been more exposed to online database searching. Also consistent with patterns suggested in the earlier literature, scientists seemed to have greater need for more current information than do either social scientists or humanities scholars. When asked what improvements they would like to see they expressed a preference for increasing the amount of information available on 24-hour dial-up access and stored on CD-ROM over extended opening hours of the library. Whereas social scientists would have chosen increasing the opening hours and improving the OPAC and humanists suggested improvements relating to library staff. Scientists were found to be more enthusiastic users of networks as well. For example, they made the most use of bulletin boards, especially in 1991 (by 1994 bulletin boards had been adopted more widely), and were more likely to have an e-mail address of their own than academics from the humanities. In view of the picture she paints, the author's conclusion, that often academics from the three traditional areas of scholarship – science, social science and the humanities – display distinct differences in their pattern of use of the new services, seems to be very justified indeed (Milne, 1999).

Disparities across different disciplines regarding most aspects of information seeking, including use of electronic resources, were found in another questionnaire survey of academic researchers conducted in 1994-1995 to discover what changes in scholarly communication had occurred in the wake of technological changes, this time in two Israeli universities Although out of 2361 questionnaires only 477 (20%) were returned, the percentage of responses among the different faculties was quite similar; thus the author saw the sample as an adequate representation of the academic population. In general, survey findings pointed to conservative patterns of obtaining information, with the professional print journal maintaining its position as the most important tool as compared to e-journals and electronic information services, which were reported to be in relatively small use. What little use of computerised data bases was made differed among the various areas of research: higher use was found among social scientist scholars – around 50%, compared to 38% among scientists and 32-33% among scholars of the humanities and Jewish studies (Shoham, 1998).

In the UK too, Erens, in his previously cited 1995 survey, found significant differences among researchers from different fields as to their acceptance and use of electronic services E-mail, electronic publications and bulletin boards were considered the most important by natural scientists; bibliographic databases and full-text services were most important for medical researchers; social scientists valued most expert discussion groups and ordering books and journals, but also considered full-text services among the most important; respondents from the humanities and arts were the least likely to consider electronic services important. Moreover, academics from different disciplines rated differently the different services available. For example, medical researchers were almost unanimous in saying bibliographic services were important (95%); next most important for them was e-mail but, at 65%, it was clearly considered much less important than their first item; of even less importance was the next highest item on their list, electronic publications, at 45%. By contrast, natural scientists gave almost equal importance to e-mail and bibliographic databases (84% and 80% respectively), followed by a large gap for their third most important item, electronic publications, at 45%. While social scientists also rated e-mail and bibliographic databases as of similar importance (at 66% and 63% respectively), there was then only a moderate drop to their item of third importance, ordering books and journals, at 54%. Finally, those in the humanities and arts gave almost equal prominence to their top three items: e-mail (53%), bibliographic databases (48%) and ordering books and journals (47%). The investigator notes in this context that access to services, or at least knowledge of access to services, varied by research discipline in a way which closely matched the importance attached to the different services. Thus, medical researchers were most likely to mention the availability of e-mail and bibliographic databases, while those in the humanities were the least likely to. Also, although there was little difference by research discipline as to the actual availability of online databases, humanities and arts researchers were the least likely to know whether such services were available and considered them a little less important than researchers in the other disciplines. In this survey too, a slower acceptance rate of the electronic services among humanities researchers could be clearly seen. Only 45% of humanities researchers reported increased use of electronic services since the previous survey of 1989, as opposed to 71% of medical researchers. Whilst 50% of natural sciences researchers, 55% of social sciences researchers and only 31% of humanities researchers made more use of (librarian mediated) database searches, as opposed to 46% of medical researchers, 39% of natural sciences researchers and 42% of social sciences researchers. However, humanists' use of online catalogues increased more or less at the same rate as that of social scientists (42% and 43% respectively), and in an accelerated rate in comparison with that of natural scientists (29%) or medical researchers (25%), probably because of humanists' greater dependence on books (Erens, 1996).

Discipline-rooted differences were also found in the already mentioned Hebrew University of Jerusalem study of Internet use among faculty. Of the 778 questionnaires sent out, 462 were returned, an overall response rate of 59.4%. The response rate was substantially lower among faculty in the social sciences (53.3%) and in the humanities (54.6%) than in the sciences (61.8%), in the three disciplines of law, social work and library science (treated as one group) (62.8%), and in agriculture (72 8%), which in itself can be seen as indicative of faculty attitude towards the Internet services proffered. Among the faculty who did respond, the least enthusiastic Internet users belonged to the group composed of law, social work and library science faculty, with only 59.3% reporting use, but again humanities faculty followed closely with 62.4%. The most avid users were science and agriculture faculty, with 90 7% and 89.6%, respectively, claiming to be Internet users. Somewhat unexpectedly, in view of the low response rate of the social sciences faculty, although considerably less so in view of the findings of previous studies, the percentage of Internet users among social sciences faculty was found to be relatively high at 86.4% However, having chosen to aggregate the data into two major groups, 'Humsoc' (which included the Faculties of the Humanities, Social Sciences and Law, plus the School of Social Work and the School of Library, Archive and Information Studies), and 'Sciagr' (which included the Faculties of Science and Agriculture and the School of Dental Medicine), the investigators' main conclusion was that faculty members in the Sciagr group tended to use the Internet more intensively than faculty members in the Humsoc group. It was noted that when viewed individually, the disciplines within the two major groups showed wide variations in use Also, aside from e-mail, used extensively and considered the most important by members of both groups, other Internet services – file transfer, listservs/newsgroups, and search interfaces – were reported to be needed and used by higher percentages of the Sciagr group as compared to the Humsoc group (Lazinger et al., 1997).

These recurrent empirical findings of discipline-originated differences between modes of research work prompted Covi and Kling to undertake a study on Digital Library (DL) use within the context of research activities in Ph.D granting institutions. Since the authors focused in their work on developing and providing a theoretical model for understanding DL use in different social worlds, interviewing for the purpose just a small sample of faculty members in two disciplines only (molecular biology and literary theory), the study does not claim to make any generalisations, but nevertheless it yields a description of the ways researchers took advantage of the academic materials that were becoming increasingly available across computer networks in the 1990s. The article depicts DL use for research purposes as follows the faculty members interviewed, and the colleagues to whom they compared themselves, were using personal computers and printers for producing documents (no researchers using typewriters were found) Few of the informants shared documents, such as drafts or pre-prints via computer networks, but all of them mentioned e-mail as an increasingly essential mode of communication (even if a few faculty confessed that they preferred not to use it despite constant pressure of peers and administrators to do so). All six literary theorists interviewed said that there was not yet a critical mass of literary theorists using e-mail to make it a necessity for everyone. In contrast, the informants in molecular biology were routine users of e-mail, even though they still transmitted most peer reviews and circulated pre-prints as paper documents via postal services After e-mail, the second most widely used electronic service was interlibrary loan, although research assistants in fact handled most electronic delivery requests Almost every faculty informant reported hearing about gopher and WWW, even if they were not connected to their campus computer network However, only one of them expressed enthusiasm for exploring resources on the Internet, and others reported that they found Internet searches to be 'frustrating, a nuisance or a time sink' Similarly, a molecular biologist described his experience with MEDLINE searching as frustrating, because of the need to do a number of searches in order to find everything relevant Many of the faculty, although willing to learn, expressed reluctance to devote the time or 'intellectual energy' required to learn yet another computer skill. However, they did prefer to search through online databases for research materials rather than ask colleagues for citations or go to the library to use printed indexes, even if most admitted they were not expert searchers. Molecular biologists, relying on journal articles for their research, depended on MEDLINE for their research materials, placing a lot of trust in this database for its thoroughness and accuracy. In literary theory similar dependence was found on the OPACs, as a result of these researchers' reliance on books. However, electronic books were not widely used, a phenomenon explained by the authors by the literary theorists in the sample retaining an affinity for the book as a symbol and artefact that could not be supplemented by the electronic text (Covi and Kling, 1996).

A 1997 cross-disciplinary survey, conducted at the University of California, Berkeley (UC Berkeley), in order to gather information on faculty and graduate student self-described use of and satisfaction with library resources and services, again points to the very same trends discerned in previous studies. Although not intended to be statistically valid and reliable, but rather an alternative to focus groups to collect qualitative data, the survey nevertheless paints the by now familiar picture of differential use and attitude among faculty. The 123 respondents (out of 282 faculty) belonging to seven departments (one interdisciplinary and the rest chosen so as to represent the three broad disciplines, the humanities, social sciences and sciences) were all intensive library users, with 99% reporting use for research purposes In addition, about 80% reported owning and using office computers with modems, and about the same percentage reported having computers with modems at home and accessing library resources remotely. In general, the more traditional resources, such as the online catalogues, were more popular with 78% searching them either 'sometimes' or 'often', but electronic abstracting and indexing sources available on the Internet or on CD-ROM were also used by 57% of the respondents, who also reported searching for information on the Web (55%) and participating in listservs (20%)

However, breakdown of the findings by departmental affiliation shows the anticipated differences in use. The percentage of Humanities faculty searching both electronic abstracts and indexes and library CD-ROM databases 'sometimes' or 'often' were mostly lower than that of either Sciences or Social Sciences faculty: whereas 15% of Ancient History and Mediterranean Archaeology faculty and 36% of Classics faculty reported using electronic abstracts and indexes. The corresponding percentage among the science departments was 81% and 38% (Chemistry and Chemical Engineering, respectively) and among the social science departments 67% and 62% (Business and Political Science, respectively). As to the use of library CD-ROM databases, none of Ancient History and Mediterranean Archaeology faculty and only 20% of Classics faculty reported searching them. The use data equalling in this instance that found in the sciences, with Chemical Engineering faculty not reporting any use whatsoever and only 19% of Chemistry faculty reporting use, but the corresponding percentage among the social science departments was again higher, with 30% and 31% (Business and Political Science respectively).

Moreover, in her comparison of faculty profiles (percentage of faculty engaging in specific library activities either sometimes or often) the percentage of Classics faculty was consistently found to be lower than that of either the Political Science faculty or Chemistry faculty whenever the use of an electronic service was under investigation Thus, for example, 18% of Classics faculty reported searching the Web, compared with 45% of Political Science faculty or 77% of Chemistry faculty, and 18% of Classics faculty said they preferred electronic resources, compared with 47% and 49%, respectively, of Political Science and Chemistry faculty. Undoubtedly the author is right in concluding from her findings, that despite widespread access to networked computers, the humanities faculty respondents seemed to conform to the picture of humanists as researchers who shy away from using electronic resources (Maughan, 1999)

Massey-Burzio (1999), in her study of humanities faculty at Johns Hopkins University in Baltimore, also found humanists to be 'less than enamoured with technology when compared to their peers in other disciplines' (p. 620). Using the focus group interview method, she elicited the opinions of the 20 participants (one quarter of the humanities faculty at Johns Hopkins) as to the value of technology to their research and teaching. Apparently, there was a great deal of electronic research material of interest to humanities scholars, but they reported difficulties in accessing it for lack of sophisticated enough equipment and/or technical support Thus, while all faculty in the focus groups used e-mail, word processing and the library's former character based online catalogue, many could neither download large files and images nor use the new web-based catalogue and databases and the Internet. However, at the same time they professed to a reluctance to invest money and time in upgrading their computers either on campus or at home. Moreover, many faculty seemed to have little respect for the Internet. Finding its Web-based windows and environment too busy, cluttered, and games-like to take seriously Consequently, only a small minority reported using the Internet, even less said they used it for a specific purpose, such as accessing an electronic journal or a specific website, with the others describing it as 'a waste of time'. The interviewees were not enthusiastic about listservs either, although some of them subscribed to several. Not surprisingly, many also expressed humanists' long-held concern about the erosion of access to books, feeling that technology cannot replace that access. Alongside these reservations and the apprehension permeating their attitude to IT based resources, all the humanities faculty in the sample felt that technology had revolutionised the way they did research in a positive and powerful way. Especially with regard to electronic indexing, which allowed for much quicker and far more efficient searches for information. However, while humanists appreciated the ability to use technology to search texts or the advantage of searching and retrieving an article via computer instead of going to the library and photocopying it, they saw no point in reading long items on the screen. Thus, says the author, summing up her findings

> Humanities faculty definitely feel the pressure to use and deal with technology. They are not completely turned off by it and are, in fact, well aware of the positive aspects of it However, they are not computer junkies. They want to use computers as a tool that works well or they will not use them (Massey-Burzio, 1999, p. 637).

Results of a 1997 nation-wide user survey, conducted in the Netherlands amongst students and academics to explore the use of the Internet for study and work related purposes, also correspond with the pattern of discipline-related differences found in the above-cited studies With no statistically significant differences found between students and faculty members, the overall percentage of Internet users in the humanities amounted to 60%, 58% of whom reported more than a year long experience, as compared to 78% of Internet users and 75% of experienced users in the social sciences, and 81% of Internet users and 76% of experienced users in the sciences (Vooribj, 1999).

In view of the consistent findings as to the existence of discipline-rooted differences among researchers in their information needs and information seeking behaviour, it is only natural that there should be variations in their readiness to adopt electronic periodicals as well. Accordingly, a survey of academic staff, carried out in late 1996 and early 1997 in five faculties of a British university, although basing its findings on a relatively small number of informants (of the 75 respondents, only 21 reported that they had used electronic journals), came up with differential results according to disciplinary affiliation Higher use was found among academics in the faculties of Business (44 4%), Engineering (30%), and Science (36 4%), than in the faculties of Education (13 3%) and Arts (9.1%). However, as Eason et al. (2000) rightly points out when remarking on this article, the results in the Faculty of Business were very much influenced by the high percentage of users within the Department of Law, whose members were involved in the production of an electronic journal, giving rise to the notion that institutional environment and culture may sometimes have more impact on use than academic specialisation A significant majority, 68.5% of the 54 academics, who identified themselves as non-users of electronic journals, gave as their reason for non-use a lack of awareness of any relevant publications Although this was the main factor clearly identified across all but one department, Physics and Applied Physics, the authors note that responses might not have distinguished between a genuine lack of awareness on the academic's part and the possibility that at the time there were no relevant electronic journals in his specific field. In some fields the availability of electronic journals was considerably more restricted than in others, for example, only 14% of the scientific journals were arts and humanities periodicals, as compared to 28% from the social sciences. Summing up their findings on an optimistic note, the authors suggest that there is a future for electronic publication, if only because academics appear willing to give it a chance But in some areas the move to the acceptance and use of electronic journals will be faster than in others, thus, they contend, in all likelihood, the arts and humanities subjects will be slower to respond to electronic journals than those in science and engineering (Tomney and Burton, 1998)

A survey conducted the following year, 1998, at Texas A&M University, also reports differing levels of e-journal acceptance among the 195 participating faculty members (out of 350). Of the faculty claiming to be aware of e-journal availability (about half of the respondents), the highest percentage (80%) were from the College of Science; Medicine was next, with 75%, followed by Engineering (54.8%), Liberal Arts (50%), and Agriculture (42.9%) Surprisingly, in the College of Business Administration only 1 of 13 respondents said he was aware of e-journals availability, but that, according to the authors, was probably due to some misunderstanding. Only 36.4% of the respondents indicated they had used e-journals, with Military Science faculty reporting the highest (100%), and Engineering and Liberal Arts faculty reporting the lowest (about 30%) level of use. It is interesting to note that although 61% (111 of 182) of all participants, and even 42.4% (29 of 68) of those who had used e-journals expressed a preference for print journals, on the whole the sampled faculty were positive about the place of electronic journals in scholarly research, with only 7 (or 3.6%) stating that e-journals could not be used for the purpose, and with 52.3% of those who had used e-journals saying they would have or already had contributed research to e-journals. (Tenner and Yang, 1999).

Findings of another survey concerned with academic uses of e-journals, this time of researchers affiliated with the Max Planck Society in Germany, demonstrate that by 1999 the subject-oriented differences in electronic journal use were still very much in existence while the biomedical specialists and the chemical-physical-technical researchers were heavy users of e-journals, researchers in the humanities section (which in fact included social sciences as well) were reported to be less active users. The authors relate these findings to the publishers' more limited offering of electronic journals in the humanities and to the currency-oriented nature of science research, as opposed to the need for a wider mixture of older and newer literature in humanities research (Rusch-Feja and Siebeky, 1999)

Diversity in user behaviour with scholarly journals was also recognised in the SuperJournal project, with the findings again pointing to disciplinary inclinations which made users in certain areas behave in certain ways (it should be noted, however, that in this study the data pertains to students as well as faculty). Thus, for example, among the types of users identified, most of the enthusiastic users (those who used SuperJournal very frequently and viewed a large number of journals) were social scientists, whereas the group of focused, regular users (those who accessed a relatively small number of journals, but seemed to return to these very frequently) were primarily scientists. In keeping with previous findings as to the differences in information needs of social scientists and scientists, the social scientists made more in-depth information retrieval, while scientists made more current awareness usage In spite of this, the author expresses some doubt as to the effect of disciplinary characteristics, saying that these might have been 'much less significant than it appeared' since in most cases the observed disciplinary difference among user types resulted from other factors, such as the uneven coverage of the journals offered in the SuperJournal project and the varied availability of competitive services (Eason et al., 2000) This is indeed a distinct possibility· for example, in the previously cited Texas A&M University study 39.5 % of the faculty not using e-journals also gave as their reason an unawareness of e-journals, and 23.4 % a lack of such journals within their academic discipline (Tenner and Yang, 1999).

Hearkening back to the opening remarks to this article, a perusal of the literature does indeed prove beyond any possible doubt that overall academia has been gradually moving to the electronic information era. Although both the speed and the extent of adoption seem to vary with subject-specialisation, not so much between the scientists and the social scientists, whose information seeking patterns reveal a considerable degree of homogeneity, as when comparing the humanities researchers with their colleagues in the sciences and the social sciences, move they do – at least, as a group. It is certainly important for all information provision policy makers in academia, on the global, the national and the local level, to be aware of this trend as a general framework for planning and development, while keeping firmly in mind that it is only through an understanding of what information individual researchers need and how they set about finding it can they ensure that suitable information systems are provided (Nicholas, 2000).

Conclusion: the challenge of custom-made information provision for the electronic-age researcher

In keeping with the commonly held notion that information technology based services and resources can and do play an increasingly important part in scholarly work, universities have been offering their faculty a plethora of ingenious modes of electronic access to information, aimed at meeting their information needs, with the libraries traditionally fulfilling groundbreaking and leadership roles in these endeavours. However, as Morrow (1999) observes, the ready availability of a technology does not guarantee its immediate take-up and exploitation, and unless it promises some personal advantage it will not change well-established practices Barry and Squires (1995) add, that no matter how useful a piece of technology appears to be in isolation, its true usefulness can be evaluated only through the perceptions of the user. Thus, a researcher's acceptance or rejection of novel methods of information gathering depends on their suitability to his personal circumstances, experience, individual capabilities and specific preferences Unlike Everest, which had to be conquered simply because it was there, the electronic systems and methods for acquiring information are perceived by researchers as a means to an end, to be chosen when it seems that the information need that arises can best be fulfilled in this way, and if deemed suitable to their individual inclinations and capabilities Although, life being more complicated than that, peer pressure can often be an overriding consideration.

This means, first and foremost that access to electronic materials can be·

> . . . liberating for some researchers, but burdensome or superfluous to others. who can continue to be successful enough using their paper-based materials and work-practices (Covi, 1997).

A longitudinal, qualitative study of a group of British social science and science academics shows this notion to be very true indeed: apparently, academics were prepared to learn and use the IT-assisted information systems only where they perceived themselves as having a need that could be met by that system, and IT was only seen as a way of augmenting research where it was appropriate. Thus, for example, one of the faculty participating in the study, a senior lecturer in education, was prompted to start searching databases for the first time because he was approached from outside to do research in an area he knew little about (Barry and Squires, 1995) This anticipation of evident advantages of what is offered as new is often the motivating force behind the decision to adopt the novel information services, or as McKnight (1997) puts it

> People think the same about electronic journals as they do about any new development – 'what advantage does it have for me?' Unless readers can see a real advantage to electronic journals, why should they use them? Unless readers can do at least the same thing – and preferably more – with electronic journals as they do with paper, what incentive is there for them to change?

Such potential advantages may include access to wider and more diverse sources of information as well as to material not otherwise available, more efficient ways of information seeking; hyperlink access to searchable and manipulable full-text documents, the ability to do information work from one's desk, circumventing the constraints of library opening hours and avoiding the notorious frustrations of library use, such as time spent searching for missing items, queues, and delays in the arrival of new journal issues; the possibility to communicate in real-time with colleagues all over the globe, etc However, when Barry and Squires (1995) put to test widespread beliefs as to the advantages of the emerging electronic library for academics, they came up with findings that indicate researchers did have some reservations. For example, they seemed to feel that the time spent searching for and reading the vast amount of literature available electronically allowed less time to think, and that data delivered to their desktop would encourage a less interactive mentality and a decrease in creative thinking (Barry and Squires, 1995)

Also, even when a researcher is perfectly willing to use the novel technologies in his information work, seeing them as potentially beneficial and suitable to his needs, a basic condition for his deciding to adopt the electronic library is an appropriate technical infrastructure, or to be more specific, the availability of equipment and access to networks. Thus, Abels et al. (1996) found, that the major deterrent to adoption of electronic networks was a lack of access to a workstation. less than 14 % of the non-users in their study had access to a networked workstation on their desk or in their work area, whereas nearly 83% of the users had workstations available from their desks In the same vein, the number of people sharing the workstation was found to be in this study another important attribute influencing adoption of the network, with only 13% of the non-users the sole users of their workstations as compared with 84% of the users It is interesting to note, however, that perceived accessibility, inclusive of proximity to and availability of workstations, which were found to influence the decision by an academic to adopt information technology, were not significant factors when considering the intensity of use and the number of services used. Since this differentiation between adoption and use was less clearly made in other studies, it can perhaps explain the inconsistent findings about whether the availability of equipment and the accessibility of networks contribute to faculty use of electronic information sources and services (see, for example, Horner and Thirwall, 1988; Fiscella and Proctor, 1995) Mackenzie Owen and Halm (1989) see perceived ease of use (lack of complexity) as another basic condition for acceptance of new technologies for information gathering. However, Abels et al. (1996) does not find it so in their study: some services were indeed perceived to be easier to use than others, but this did not appear to be a factor that influenced the decision to adopt. In any case, there seems to be little doubt that technological readiness plays an important part in researchers' move to the electronic era, although, as mentioned above, it is not very clear whether the technologically developed environment brings about greater acceptance of novel information seeking methods, or perhaps it is the other way round, with information needs driving the provision of appropriate technologic infrastructures.

Evidently, the increasing adoption of electronic resources does not mean that all researchers are ready for them, and not even that those willing to accept some of the novel technologies are prepared to have them replace altogether traditional modes of communication and information gathering, at least not yet Still, recognising the variations in information needs of researchers and understanding the motivating forces behind their adoption of innovative information technologies for meeting these needs will aid universities in attaining the goal of creating custom-made personal information infrastructures, tailored to the distinctive needs of individual researchers.

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